# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

## DEPARTMENT OF CHEMICAL ENGINEERING

## PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

B.Tech –Chemical Engineering | Academic Year: 2019-20

### PROGRAM OUTCOMES

**[PO.1].Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2].Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3].Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

**[PO.4].Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

**[PO.5].Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6].The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

**[PO.7].Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8].Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9].Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10]. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## PROGRAM SPECIFIC OUTCOMES

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**[PSO.2]. Process Intensification:** Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

**Program Articulation Matrix**

| | Subject Code | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEM I | CS1001 | 3 | 1 | 3 | | | | | | | | | 3 | | | |
| | CS1030 | 3 | 1 | 3 | | | | | | | | | 3 | | | |
| | CV1001 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | | 3 | 2 | 3 | 3 | | | |
| | CY1001 | 2 | 2 | 2 | | 3 | | 3 | 2 | | 3 | | 3 | | | |
| | CY1002 | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | | 1 | 3 | | | |
| | CY1030 | 2 | | 2 | | 3 | | 3 | 2 | | 3 | | 3 | | | |
| | EC1001 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | | | | | 2 | | | |
| SEM II | EE1001 | 3 | 2 | 1 | | | 1 | 1 | | | | | 3 | | | |
| | LN1001 | | 1 | | | | 1 | | 2 | 2 | 2 | 1 | | | | |
| | MA1101 | 3 | 3 | 2 | 3 | 3 | | | | 3 | | 3 | 1 | | | |
| | ME1001 | 3 | 3 | 3 | 2 | | 2 | 2 | | | | | | | | |
| | ME1002 | 3 | 3 | 3 | 2 | 3 | | | | | | | 2 | | | |
| | ME1030 | 1 | 1 | | | 1 | | 1 | | 1 | | 1 | 1 | | | |
| | PY1001 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | |
| | PY1030 | 3 | 3 | 1 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | | | |
| SEM III | BB1101 | | | | | | 1 | 3 | 2 | 1 | 2 | 1 | 2 | | | 3 |
| | MA1310 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | | 2 | 1 | 2 | 1 | | | |
| | CY 1321 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | | 1 | 1 |
| | CE1305 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | | | 3 | 3 | 2 | 1 |
| | CE1306 | 3 | 3 | 2 | 1 | | 1 | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 |
| | CE1307 | 3 | 3 | 3 | 2 | | 3 | | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| | CE1304 | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 |
| SEM IV | CE1405 | 3 | 3 | | | 3 | | 2 | | 2 | | 2 | | 3 | 2 | |
| | CE1406 | 3 | 3 | 2 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 2 | 1 | 3 | 3 | 2 |
| | CE1407 | 3 | 3 | 1 | 1 | | 2 | 2 | | | | 2 | 3 | 3 | 1 | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CE1408 | 3 | 3 | 1 | | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 1 | 3 | 3 | 3 |
| | CY1421 | 2 | 2 | 2 | | 3 | | 3 | 2 | | 3 | | 3 | 3 | 1 | 3 |
| **SEM V** | CE1505 | 3 | 3 | | 1 | 2 | 2 | 3 | | 3 | 2 | | 1 | 3 | 2 | 1 |
| | CE1506 | 3 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | | 1 | 2 | 3 | 1 | 2 |
| | CE1507 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | | 2 | 2 | 1 | 2 | 2 | 3 | 1 |
| | CE1553 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | | | | | 2 | 1 | 3 |
| | CE1554 | | 3 | 1 | 1 | 3 | 2 | 3 | 1 | 1 | 1 | | 1 | | | 3 |
| **SEM VI** | CE1604 | 1 | | 2 | 3 | | | 2 | | | | | | 2 | 1 | 1 |
| | CE1605 | 3 | 3 | 1 | | 2 | | 2 | | 2 | 2 | 1 | 1 | 3 | | 2 |
| | CE1606 | 3 | 3 | | | | | 1 | 2 | 3 | 2 | | | | 1 | |
| | CE1653 | 2 | 2 | | 1 | | 2 | 2 | 2 | 3 | | 2 | | 2 | | 3 |
| | CE1654 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | | 3 | 1 | 3 | 2 | 3 |
| | PS1601 | 1 | 2 | 2 | | | 3 | | 1 | | | 1 | 3 | | | |
| **SEM VII** | CE1705 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| | CE1706 | 3 | 3 | 1 | | 3 | | 2 | 3 | 2 | 1 | 3 | | 3 | 3 | 2 |
| | CE1707 | 3 | 3 | 3 | | 3 | 1 | 1 | | 2 | 1 | | 1 | 3 | 2 | |
| | CE1708 | | 2 | 1 | 1 | | | | 2 | 1 | 2 | 3 | | 1 | 2 | |
| | CE1753 | 2 | 1 | 2 | 1 | | 3 | 2 | 1 | | | | 1 | 1 | 1 | 2 |
| | CE1754 | 3 | 3 | 3 | 3 | | 2 | 3 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| **SEM VIII** | CE1803 | 3 | 2 | | | 2 | | | 1 | 2 | | 1 | 1 | 1 | 3 | 1 |
| | CE1804 | 3 | 3 | 1 | | 3 | 1 | 1 | | 2 | 1 | 1 | 1 | 2 | 1 | 2 |
| | | | | | | | | | | | | | | | | |
| TOTAL | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

MANIPAL UNIVERSITY
JAIPUR

School of Computing and Information Technology

Course Hand-out

**Problem Solving Using Computers**
| CS 1001 | 3 Credits | 3 0 0 3

Session: 2019-20 (odd Sem.) | Faculty: Dr. Punit Gupta, Mr Nitesh Pradhan, Dr Shivani Gupta, Ms. Neha Sharma, Dr Hemlata Goyal, Mr Harish Sharma, Ms. Shikha Mundra, Ms. Vinita Soni | Class: B.Tech 1st Year

**A.** **Introduction:** Programming in C focuses on basic computer fundamentals, number system and programming fundamentals. By means of C language students learn to write set of instruction to create a program so that desire output can be generated by computer.

**B.** **Course Outcomes:** At the end of the course, students will be able to

**[1001.1].** Demonstrate bitwise operations and conversion of numbers in different representations through Number System.

**[1001.2].** Demonstrate a deep knowledge of computer for better understanding of devices, basic fundamental of computer comprises in this course.

**[1001.3].** Design flow chart, Write algorithm and pseudo code parallel with Control Statements to understand flow of program execution.

**[1001.4].** Create memory oriented operation using pointers and understating programming skills by Array, Structure, Union, Enum and String are added.

**[1001.5].** Create program using concept of re-usability by means of functions in C.

**[1001.6].** Illustrate the concept of data base by using file handling.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**[PO.1].** **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2].** **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3].** **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

**[PO.4].** **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

**[PO.5].** **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

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**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 20 |
| | Sessional Exam II (Close Book) | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 20 |
| End Term Exam (Summative) | End Term Exam (Close Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

Digital computer fundamentals: Algorithms and flowcharts, the von Neumann architecture, programs, assembly language, high level programming languages; Number System: binary, decimal, octal,

hexadecimal; Imperative programming (Using C): data types, variables, operators, expressions, statements, control structures, functions, arrays and pointers, recursion, records (structures), files, input/output, some standard library functions and some elementary data structures.

**F. Text Books**

T1. E. Balagurusamy, "Programming in ANSI C", 7th Edition, McGraw Hill Publication, 2016.

T2. Y. P. Kanetkar, "Let us C", 12th Edition, BPB Publication, 2014.

**G. Reference Books**

R1. B. W. Kernighan, D. M. Ritchie, "The C Programing Language", 2nd Edition, Prentice Hall of India, 2014.

R1. B. Gottfired, "Schaum's Outline Series: Programming with C", 3rd Edition, McGraw Hill Publication, 2012.

**H. Lecture Plan:**

| lecture | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode Of Assessing CO |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 1 | Number systems: decimal, binary, octal, hexadecimal, base-r conversions | To acquaint knowledge about basics of number system | Lecture | 1001.1 | Mid Term I, Quiz & End Term |
| 2 | Number systems: decimal, binary, octal, hexadecimal, base-r conversions | To acquaint knowledge about basics of number system | Flipped Classroom | 1001.1 | Mid Term I, Quiz & End Term |
| 3 | Basic architecture of computers and its building block | Describing basic architecture of computer | Lecture | 1001.2 | Mid Term I, Quiz & End Term |
| 4 | Computer languages: machine language, assembly language, high level language; translators: assembler, compiler, interpreter | Differentiate between machine language and high level language | Lecture | 1001.2 | Mid Term I, Quiz & End Term |
| 5 | Short history, character set, tokens | Describing basics of datatype, token and keywords with differentiation between them. | Guided Self-Study | 1001.3 | Mid Term I, Quiz & End Term |
| 6 | Constants (integer, real, character, string); variables, keywords | Describe and implementation of various contant type | Lecture | 1001.3 | Mid Term I, Quiz & End Term |
| 7 | Data types ( table including range, memory and format specifier) | Implementation of various data type | Lecture | 1001.3 | Mid Term I, Quiz & End Term |
| 8 | Operators: arithmetic, relational, logical, assignment | Implementation of various arthematic operations | Lecture | 1001.3 | Mid Term I, Quiz & End Term |
| 9 | Bitwise, conditional, type-cast, sizeof, comma | Implementation of various operators | Lecture | 1001.3 | Mid Term I, Quiz & End Term |
| 10 | Operator precedence and associativity, type conversion | Implementation of precedence in programing | Activity (Think Pair Share) | 1001.3 | Mid Term I, Quiz & End Term |
| 11 | Operator precedence and associativity, type conversion | Implementation of precedence in programing | Lecture | 1001.3 | Mid Term I, Quiz & End Term |
| 12 | Input and output statements (formatted and unformatted) : printf, scanf | Implementation of input and output statements | Lecture | 1001.3 | Mid Term I, Quiz & End Term |
| 13 | Gets, puts, getchar, putchar | Implementation of input and output statements using system functions | Activity (Jigsaw) | 1001.3 | Mid Term I, Quiz & End Term |
| 14 | Decision statements: if, if-else, nested if-else, if-else ladder | Implementation of decision statements | Lecture | 1001.3 | Mid Term I, Quiz & End Term |
| 15 | Decision statements: if, if-else, nested if-else, if-else ladder | Implementation of decision statements | Lecture | 1001.3 | Mid Term I, Quiz & End Term |

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|---|---|---|---|---|---|
| 16 | Switch, break statement | Learning the implementation of switch and break | Flipped Class | 1001.3 | Mid Term I, Quiz & End Term |
| 17 | Switch, break statement | Learning the implementation of switch and break | Lecture | 1001.3 | Mid Term I, Quiz & End Term |
| 18 | Repetitive structures: for, while, do-while | Learning the implementation of looping | Lecture | 1001.3 | Mid Term II, Quiz & End Term |
| 19 | Repetitive structures: for, while, do-while | Learning the implementation of looping | Lecture | 1001.3 | Mid Term II, Quiz & End Term |
| 20 | Nested loops | Learning the implementation of looping | Activity (Think Pair Share) | 1001.3 | Mid Term II, Quiz & End Term |
| 21 | Nested loops | Learning the implementation of looping | Lecture | 1001.3 | Mid Term II, Quiz & End Term |
| 22 | Continue and break statements | Describe the usage of continue and break | Lecture | 1001.3 | Mid Term II, Quiz & End Term |
| 23 | Continue and break statements | Describe the usage of continue and break | Lecture | 1001.3 | Mid Term II, Quiz & End Term |
| 24 | 1-D array: definition, declaration, initialization, input array, output array | Describe and define array of various data type | Lecture | 1001.4 | Mid Term II, Quiz & End Term |
| 25 | 1-D array: definition, declaration, initialization, input array, output array | Describe and define array of various data type | Lecture | 1001.4 | Mid Term II, Quiz & End Term |
| 26 | 1-D character array: character array, string, string standard function | Describe and define array of various data type | Lecture | 1001.4 | Mid Term II, Quiz & End Term |
| 27 | 1-D character array: character array, string, string standard function | Describe and define array of various data type | Lecture | 1001.4 | Mid Term II, Quiz & End Term |
| 28 | 1-D character array: character array, string, string standard function | Describe and define array of various data type | Lecture | 1001.4 | Mid Term II, Quiz & End Term |
| 29 | 2-D array: definition, declaration, initialization, input array, output array, one simple program | Describe and define array of various data type | Lecture | 1001.4 | Mid Term II, Quiz & End Term |
| 30 | 2-D array: definition, declaration, initialization, input array, output array, one simple program | Describe and define array of various data type | Lecture | 1001.4 | Mid Term II, Quiz & End Term |
| 31 | 2-D array: definition, declaration, initialization, input array, output array, one simple program | Describe and define array of various data type | Lecture, Activity | 1001.4 | Mid Term II, Quiz & End Term |

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|---|---|---|---|---|---|
| 32 | Pointers: introduction | Describe functionality of pointers in programming' | Lecture | 1001.4 | Mid Term II, Quiz & End Term |
| 33 | 1-D Array and pointer | Implementation of ID array with pointer | Lecture | 1001.4 | Mid Term II, Quiz & End Term |
| 34 | Functions: introduction to functions | Describe importance of fuction and modular programming | Lecture, Activity | 1001.5 | Mid Term II, Quiz & End Term |
| 35 | Function prototype, call, definition | Describe importance of fuction and modular programming | Lecture | 1001.5 | Mid Term II, Quiz & End Term |
| 36 | Storage classes | Describe usage of storage classes | Lecture | 1001.5 | Mid Term II, Quiz & End Term |
| 37 | Structures: definition, declaration, initialization, array of structures | Describe usage of structures | Lecture | 1001.4 | Quiz & End Term |
| 38 | Structures: definition, declaration, initialization, array of structures | Describe usage of structures | Lecture | 1001.4 | Quiz & End Term |
| 39 | Union, difference between union and structures | Describe usage of union | Lecture | 1001.4 | Quiz & End Term |
| 40 | File handling: introduction, operations on files, opening modes | Describe usage of file handling with various operations and modes | Lecture | 1001.6 | Quiz & End Term |
| 41 | File handing function | Describe usage of file handling with various operations and modes | Lecture | 1001.6 | Quiz & End Term |
| 42 | File handing function | Describe usage of file handling with various operations and modes | Lecture | 1001.6 | Quiz & End Term |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| CS 1001.1: | Understand bitwise operations and conversion of numbers in different representations through Number System. | 2 | | | | | | | | | | | 1 |
| CS 1001.2: | Described a deep knowledge of computer for better understanding of devices, basic fundamental of computer comprises in this course. | 2 | | | | | | | | | | | |
| CS 1001.3: | Design flow chart, Write algorithm and pseudo code parallel with Control Statements to understand flow of program execution. | 2 | | 1 | | | | | | | | | 2 |
| CS 1001.4: | Developing ability in students to learn memory oriented operation using pointers and understating programming skills by Array, Structure, Union, Enum and String are added. | 3 | 1 | 3 | | | | | | | | | 2 |
| CS 1001.5: | Students learnt the concept of reusability by means of functions in C. | 3 | | 3 | | | | | | | | | 3 |
| CS 1001.6: | Illustrate the concept of data base by using file handling. | 3 | | | | | | | | | | | 1 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

MANIPAL UNIVERSITY
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School of Computing and Information Technology

Course Hand-out

**Problem Solving Using Computers Lab**
| CS 1030 | 1 Credit | 0 0 1 1

Session: 2019-20 (odd Sem.) | Faculty: Dr. Punit Gupta, Mr Nitesh Pradhan, Dr Shivani Gupta, Ms. Neha Sharma, Dr Hemlata Goyal,Mr Harish Sharma, Ms. Shikha Mundra, Ms. Vinita Soni | Class: B.Tech 1st Year

**A. Introduction:** Problem Solving Using Computers focuses on basic computer fundamentals, number system and programming fundamentals. By means of C language students learn to write set of instruction to create a program so that desire output can be generated by computer.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1030.1].** Demonstrate bitwise operations and conversion of numbers in different representations through Number System.

**[1030.2].** Demonstrate a deep knowledge of computer for better understanding of devices, basic fundamental of computer comprises in this course.

**[1030.3].** Design flow chart, Write algorithm and pseudo code parallel with Control Statements to understand flow of program execution.

**[1030.4].** Create memory oriented operation using pointers and understating programming skills by Array, Structure, Union, Enum and String are added.

**[1030.5].** Create program using concept of re-usability by means of functions in C.

**[1030.6].** Illustrate the concept of data base by using file handling.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**[PO.1]. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2]. Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3]. Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

**[PO.4]. Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

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**[PO.12].** **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Lab | Practical Lab Exam | 50 |
| | Day to Day Assessment | 50 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

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**H. Lab Experiment Plan:**

| lecture | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode Of Assessing CO |
|---|---|---|---|---|---|
| 1 | Algorithms and Flow Charts | Describe the flowcharts and design of algorithm | Lecture | 1030.1 | Mid Term Lab Assessments and End Term Lab Assessment |
| 2 | Working with Linux Commands | Use Unix commands to manage files and develop programs, including multi-module programs | Lecture | 1030.1 | Mid Term Lab Assessments and End Term Lab Assessment |
| 3 | Formula based C Programs | Understand the fundamentals of C programming. | Lecture | 1030.2 | Mid Term Lab Assessments and End Term Lab Assessment |
| 4 | Control Structures: If statement | Choose the loops and decision making statements to solve the problem. | Lecture | 1030.2 | Mid Term Lab Assessments and End Term Lab Assessment |
| 5 | Control Structures: Switch | Choose the loops and decision making statements to solve the problem. | Lecture | 1030.3 | Mid Term Lab Assessments and End Term Lab Assessment |
| 6 | Control Structures: Loops | Choose the loops and decision making statements to solve the problem | Lecture | 1030.3 | Mid Term Lab Assessments and End Term Lab Assessment |
| 7 | Control Structures: Nested Loops | Choose the loops and decision making statements to solve the problem | Lecture | 1030.3 | Mid Term Lab Assessments and End Term Lab Assessment |
| 8 | 1-D Array | Implement different Operations on arrays | Lecture | 1030.3 | Mid Term Lab Assessments and End Term Lab Assessment |
| 9 | 2-D Arrays | Implement different Operations on arrays | Lecture | 1030.4 | Mid Term Lab Assessments and End Term Lab Assessment |
| 10 | Strings | Implementation of precedence in programing | Lecture | 1030.4 | Mid Term Lab Assessments and End Term Lab Assessment |

| | | | | | |
|---|---|---|---|---|---|
| 11 | Functions | Use functions to solve the given problem | Lecture | 1030.5 | Mid Term Lab Assessments and End Term Lab Assessment |
| 12 | Pointers | Understand pointers, structures and unions | Lecture | 1030.5 | Mid Term Lab Assessments and End Term Lab Assessment |
| 13 | Structures | Understand pointers, structures and unions | Activity (Jigsaw) | 1030.6 | Mid Term Lab Assessments and End Term Lab Assessment |
| 14 | End Term Exam | | | | Mid Term Lab Assessments and End Term Lab Assessment |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| CS 1030.1: | Demonstrate bitwise operations and conversion of numbers in different representations through Number System. | 2 | | | | | | | | | | | 1 |
| CS 1030.2: | Demonstrate a deep knowledge of computer for better understanding of devices, basic fundamental of computer comprises in this course. | 2 | | | | | | | | | | | |
| CS 1030.3: | Design flow chart, Write algorithm and pseudo code parallel with Control Statements to understand flow of program execution. | 2 | | 1 | | | | | | | | | 2 |
| CS 1030.4: | Create memory oriented operation using pointers and understating programming skills by Array, Structure, Union, Enum and String are added. | 3 | 1 | 3 | | | | | | | | | 2 |
| CS 1030.5: | Create program using concept of re-usability by means of functions in C. | 3 | | 3 | | | | | | | | | 3 |
| CS 1030.6: | Illustrate the concept of data base by using file handling. | 3 | | | | | | | | | | | 1 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Civil Engineering
Course Hand-out

Basic Civil Engineering | CV1001| 3 Credits | 3 0 0 3

Session: Jul 19 – Nov 19 | Faculty: Dr. Jitendra Singh Yadav | Class: B.Tech (First Year)

## A. Introduction:

This course is offered by Dept. of Civil Engineering as a departmental core course. The main objectives of this course are to understand, basics of civil engineering with are essential for everyone. The course covers principle of surveying, method and equipment's used for surveying, building material used for construction, different components of building, forces and its equilibrium, evaluation of centre of gravity and moment of inertia of simple and composite sections, simple stress and strain, method of analysis of truss, estimation and costing. Overall, this course will help to understand the basic of civil engineering used in our day to day life.

## B. Course Outcomes: At the end of the course, students will be able to

**[CV1001.1].** Describe the importance and role of Civil Engineering and Civil Engineer in development of Society.

**[CV1001.2].** Explain surveying and the type of instruments used for surveying.

**[CV1001.3].** Describe the scientific terminologies related to building materials and components of building.

**[CV1001.4].** Assess the force acting on a materials, centre of gravity and moment of inertia of composite area.

**[CV1001.5].** Calculate the different type of stress like, simple stress, shear stress, and direct stress and strain in the material, and analysis of truss. Familiar to basic terminologies related to Estimation and Costing which create employability, and entrepreneurship.

## Program Outcomes and Program Specific Outcomes

**[PO.1]. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2]. Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3]. Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

**[PO.4]. Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

**[PO.5]. Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6]. The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

**[PO.7]. Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8]. Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9]. Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10]. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## C. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 20 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## D. Syllabus

**Introduction:-** Scope of Civil Engineering, Role of Civil Engineer in Society, Impact of infrastructural development on economy of country; **Surveying:-**Principles and types of surveying, Site plans, Linear measurements, Angular measurements, Levelling, ordinary levels and total stations, Use of theodolite and plane table, contouring, L- section and cross sections; **Buildings:-** Properties, uses of Stones, bricks, cement, timber, steel, plastics and paints. Properties of concrete. Selection of site for Buildings, Layout of building Plan, Types of buildings, Plinth Area, Carpet Area, Super built up area, floor space index, building bye laws, ventilation, components of buildings and their functions, Functional design of buildings, basic concepts of R.C.C., Type of foundations; **Mechanics of Solids**:- Forces and Equilibrium, Graphical and analytical treatment of concurrent and non-concurrent co-planer forces, Free body diagram, Frictional force in equilibrium problems; **Centroid and centre of gravity**, Moment of inertia of simple and composite areas; **Normal stress and strain**, Hooke's law, modulus of elasticity, modulus of rigidity, allowable stress, shear stress and shear strain; **Analysis of plane truss**, Method of joints, Method of sections; **Estimation and Costing**:- Types of estimates and Contracts, Tenders, NIT, EMD and Security deposits, Award of work, measurements, billing and payments.

**E. Text Books**

**T1.** Ramamrutham S., Basic Civil Engineering (3e), Dhanpat Rai Publishing Company (P) Ltd, 2013.

**T2.** Punamia B. C., Jain A. K., Jain A. K., Surveying Volume 1 (16e), S Chand, 2016.

**T3.** Dutta B. N., Estimation and Costing in Civil Engineering (28e), UBS Publishers Distributors LTD., 2016.

**T4.** Punamia B.C., Jain A. K., Jain A. K., Building Construction (11e), S Chand, 2016.

**T5.** Khurmi R. S., Strenght of Material, S Chand, 2016

**T6.** Timoshenko S., Young D.H., Rao J.V., Pati S., Engineering Mechanics (5e), Mcgraw Hill, 2013.

**T7.** SP41 Handbook on Functional Design of Buildings, Bureau of Indian Standards 2013.

**Reference Books**

**R1.** Timoshenko S., Young D.H., Rao J.V., Pati S., Engineering Mechanics (5e), Mcgraw Hill, 2013.

**R2.** SP41 Handbook on Functional Design of Buildings, Bureau of Indian Standards 2013.

**F. Lecture Plan:**

| Lec No | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1,2 | Introduction | Scope of Civil Engineering, Role of Civil Engineer in Society, | Lecture | 1001.1 | NA |
| 3 | Introduction | Impact of infrastructural development on economy of country | Lecture | 1001.1 | In Class Quiz |
| 4,5 | Surveying | Principles and types of surveying, Site plans, Linear measurements, | Lecture and field visit | 1001.2 | In Class Quiz<br>End Term |
| 6,7,8 | Surveying | Angular measurements, Levelling, ordinary levels and total stations | Lecture and field visit | 1001.2 | Home Assignment<br>End Term |
| 9,10,11 | Surveying | Use of theodolite and plane table, contouring, L- section and cross sections | Lecture and field visit | 1001.2 | In Class Quiz<br>End Term |
| 12 | Building | Properties, uses of Stones, bricks, cement, | Lecture and field visit | 1001.3 | Class Quiz<br>Mid Term I<br>End Term |
| 13 | Building | Timber, steel, plastics and paints. | Lecture and field visit | 1001.3 | Class Quiz<br>Mid Term I<br>End term |
| 14,15 | Building | Properties of concrete. | Lecture | 1001.3 | Home Assignment<br>Class Quiz<br>Mid Term I<br>End Term |
| 16,17 | Building | Selection of site for Buildings, Layout of building Plan, Types of buildings, Plinth Area, Carpet Area, Super built up area, floor space index, building bye laws, ventilation, components of buildings and their functions, | Lecture | 1001.3 | Class Quiz<br>Mid Term I<br>End Term |
| 18,19 | Building | Functional design of buildings, basic concepts of R.C.C., Type of foundations. | Lecture | 1001.3 | Class Quiz<br>Mid Term I<br>End Term |
| 20 | Mechanics of Solids | Forces and Equilibrium, | Lecture | 1001.4 | Class Quiz<br>End Term |
| 21 | Mechanics of Solids | Graphical and analytical treatment of concurrent and non-concurrent co-planer forces, Free body diagram | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 22 | Mechanics of Solids | Frictional force in equilibrium problems | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 23,24,25 | Mechanics of Solids | Numerical Exercises | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 26 | Mechanics of Solids | Centroid and centre of gravity, | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 27 | Mechanics of Solids | Moment of inertia of simple and composite areas. | Lecture | 1001.4 | Class Quiz<br>End Term |
| 28,29,20,31 | Mechanics of Solids | Numerical Exercises | Lecture | 1001.4 | Class Quiz<br>End Term |
| 32 | Mechanics of Solids | Normal stress and strain,<br>Hooke's law | Lecture | 1001.5 | Class Quiz<br>End Term |
| 33 | Mechanics of Solids | Modulus of elasticity, modulus of rigidity | Lecture | 1001.5 | Class Quiz<br>End Term |
| 34 | Mechanics of Solids | Allowable stress, shear stress and shear strain | Lecture | 1001.5 | Class Quiz<br>End Term |
| 35, 36 | Mechanics of Solids | Numerical Exercises | Lecture | 1001.5 | Class Quiz<br>End term |
| 37 | Structure Analysis | Analysis of plane truss, Method of joints, | Lecture | 1001.5 | Class Quiz |
| 38 | Structure Analysis | Method of sections | Lecture | 1001.5 | Class Quiz<br>Mid Term II<br>End Term |
| 39,40,41 | Structure Analysis | Numerical Exercises | Lecture | 1001.5 | Class Quiz<br>Mid Term II<br>End Term |
| 42 | Estimation and Costing | Types of estimates and Contracts, | Lecture | 1001.5 | Class Quiz<br>Mid Term II<br>End Term |
| 43 | Estimation and Costing | Tenders, NIT, EMD and Security deposits, | Lecture | 1001.5 | Class Quiz<br>End Term |
| 44 | Estimation and Costing | Award of work, measurements, billing and payments | Lecture | 1001.5 | Class Quiz<br>End Term |
| 45,46 | Estimation and Costing | Numerical Exercises | Lecture | 1001.5 | Class Quiz<br>End Term |

**G. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| CV 1001.1 | Importance and role of Civil Engineering and civil engineer in development of Society. | | | 1 | | | 1 | 2 | | | 1 | | 1 |
| CV 1001.2 | Get familiar with surveying and the type of instruments used for surveying. | 2 | 1 | 2 | 3 | 3 | | | | 3 | | | |
| CV 1001.3 | Describe the scientific terminologies related to building materials and components of building. | 3 | 3 | 2 | | 2 | 2 | 1 | | 2 | | | 3 |
| CV 1001.4 | Assess the force acting on a materials, centre of gravity and moment of inertia of composite area. | 3 | 3 | | | | | | | | | | |
| CV 1001.5 | Calculate the different type of stress like, simple stress, shear stress, and direct stress and strain in the material, and analysis of truss. Familiar to basic terminologies related to Estimation and Costing which create employability, and entrepreneurship. | 3 | 2 | 1 | | | | | | | 2 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

Faculty of Engineering

Department of Chemistry
Course Hand-out

Engineering Chemistry | CY1001 | 3 Credits | 2 1 0 3

Session: Jul 19 – Nov 19 | Coordinator: Arunava Agarwala | Class: B.Tech. (I and II Sem)

**A. Introduction:** This course is offered by Dept. of Chemistry for all 1st year B.Tech. students. The objective of the course is to acquaint the students with the basic concepts of chemistry relevant to engineering field.The students with the knowledge of basic chemistry, will understand and explain scientificallythe various chemistry related problems in the industry/engineering field.

**B. Course Objectives:** At the end of the course, students will be able to

**[1001.1].** Understand and apply concepts of various types of fuel technology
**[1001.2].** Develop skill of synthesis and applications of polymer and some advanced materials.
**[1001.3].** Explain different the water softening methods.
**[1001.4].** Understand and apply the concepts in electrochemistry and corrosion science in protecting metallic objects.
**[1001.5].** Apply the concept of phase rule to construct phase diagram
**[1001.6].** Develop skill in various modern analytical techniques.

**C. Program Outcomes and Program Specific Outcomes**

**[PO.1].** **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2].** **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3].** **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public healthand safety, and the cultural, societal, and environmental considerations

**[PO.4].** **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

**[PO.5].** **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6].** **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal,health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineeringpractice

**[PO.7].** **Environment and sustainability**: Understand the impact of the professional engineering solutions insocietal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8].** **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of theengineering practices

**[PO.9].** **Individual and team work**: Function effectively as an individual, and as a member or leader in diverseteams, and in multidisciplinary settings

**[PO.10].** **Communication**: Communicate effectively on complex engineering activities with the engineering

community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projectsand in multidisciplinary environments

**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Mid Term Examination I | 20 |
| | Mid Term Examination II | 20 |
| | Quiz tests (Accumulated and Averaged) | 20 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work at home/ hostel especially before a quiz test or MTE-I/MTE-II. A student is expected to participate and perform these assignments with full zeal since the activity. | |

## E. Syllabus

**Unit-I** Classification of Fuels, Gross Calorific value and Net Calorific value. Solid, Liquid and Gaseous fuels.
**Unit-II:** Advanced materials and polymers: Liquid crystals, ceramics, composites, bio-materials, nanomaterials, thin films and their properties and applications.
**Unit-III:** Water treatment technology.
**Unit- IV:** Concept of corrosion and its importance, types of corrosion, factors affecting corrosion, Corrosion control methods. Chemistry of primary and secondary batteries. Working principles of fuels cells and their applications.
**Unit-V:** Theory and application phase rule (up to two component system).
**Unit VI;** General methods of chemical analysis, Instrumental methods. Introduction to spectroscopic methods of analysis: Electromagnetic radiation (EMR), Interaction of EMR with matter, Numerical Problems. Concepts of rotational, vibrational and electronic spectra, Laws of spectrophotometry

## F. Text Books

T1. Jain P.C. and Jain M., Engineering Chemistry, Dhanpat Rai and Sons, Delhi, Revised, 15th Edn. 2006.

T2. Kuriacose J.C., Raja R. J., Chemistry in Engineering and Technology, Vol. I/II TMH 1988

## G. Reference Books

*No reference books required for this course.*

**H. Lecture Plan:**

| Lec No | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1. | **Chemical fuels:** Introduction, Classification, Calorific value. Gross calorific value and net Calorific value. Determination of calorific value by Bomb calorimeter. | To acquaint and clear teachers expectations and understand student expectations | Lecture | 1001.1 | Class Quiz<br>End Term |
| 2. | Determination of calorific value by Boys; Numerical problems based on Bomb and Boys calorimeter. | Working of the calorimeter | Lecture, Activity | 1001.1 | Class Quiz<br>Mid Term I |
| 3. | Dulong formula; Numerical problems. | Analyse and solve numerical problems | Lecture, Activity | 1001.1 | Class Quiz<br>End Term |
| 4. | Solid fuels – Coal and its analysis – Proximate and Ultimate analysis. | Analyse and solve numerical problems | L Lecture, Activity | 1001.1 | Home Assignment<br>End Term |
| 5. | Liquid Fuels: Fractional Distillation, Petroleum cracking - catalytic cracking (Fixed Bed and moving bed) and Reforming of petroleum, Synthetic Petrol: Burgius process, Fisher Trophch method. Composition and applications of water gas, Producer gas. | Principles of distillation, cracking | Lecture | 1001.1 | Class Quiz<br>End Term |
| 6. | Numerical based on Combustion ( By Weight Type and By Volume Type ) | Analyse and solve numerical problems | Lecture, Activity | 1001.2 | Class Quiz<br>Mid Term I<br>End Term |
| 7. | **Advanced materials and polymers:** Introduction, Definition, classification of polymers – based on origin, thermal behaviour, Polymerization reactions and applications, Tacticity. Functionality, Degree of polymerization, Co-polymerization – alternating, random, block and graft polymers | Describe the working of polymer | Lecture | 1001.2 | Class Quiz<br>Mid Term I<br>End term |
| 8. | Mechanism of free radical polymerization and ionic polymerization. Mechanism of coordination polymerization, Condensation polymerization reactions, Glass transition temperature & factors affecting it | Describe mechanization of polymerization | Lecture | 1001.2 | Class Quiz<br>Mid Term I<br>End Term |
| 9. | Molecular weight of polymers, Number average and weight average molecular weights, Numerical problems. | Analyse and solve numerical problems | Lecture, Activity | 1001.2 | Class Quiz<br>Mid Term I<br>End Term |
| 10. | Preparation, properties and applications of Polythene (LDPE and HDPE), Nylon( 6:6, 6, 6:10, | Identify alternative ways to synthesize rubbers. | Lecture | 1001.2 | Class Quiz<br>Mid Term I |

| | | | | | |
|---|---|---|---|---|---|
| | 11), PF resins and Polyester. Natural rubber, Processing of Natural Rubber, Vulcanization, Compounding of rubber; Synthetic Rubber: Buna-N, Buna-S | | | | End Term |
| 11. | Liquid crystals: their properties and applications | Gain knowledge of liquid crystals | Lecture | 1001.2 | Class Quiz<br>End Term |
| 12. | Ceramics: Properties and applications | Gain knowledge of ceramics | Lecture | 1001.2 | Class Quiz<br>Mid Term I<br>End Term |
| 13. | Composites and bio-materials: properties and applications | Gain knowledge of bio-materials | Lecture | 1001.2 | Class Quiz<br>Mid Term I<br>End Term |
| 14. | Nanomaterials and thin films: Properties and applications | Understand basics of nanochemistry | Lecture | 1001.2 | Class Quiz<br>Mid Term I<br>End Term |
| 15. | Revision | Recall and recap the lessons learnt during last 14 lectures | Lecture, Activity | | Class Quiz<br>Mid Term I<br>End Term |
| 16. | **Water Technology:** Introduction, Characteristics imparted by impurities in water, Hardness of water Degree of hardness. | Describe the properties of water and its aplication | Lecture | 1001.3 | Class Quiz<br>Mid Term II<br>End Term |
| 17. | Determination of hardness by EDTA method. Numerical problems. | Describe working hardness/softness of water | Lecture, Activity | 1001.3 | Class Quiz<br>Mid Term II<br>End Term |
| 18. | Softening of hard water: Internal treatment by phosphate and calgon condition. Softening of hard water: External treatment by lime soda process. | Describe working hardness/softness of water | Lecture | 1001.3 | Class Quiz<br>Mid Term II<br>End Term |
| 19. | Softening of hard water: Ion exchange method; Zeolite methods | Describe working hardness/softness of water | Lecture. | 1001.3 | Class Quiz<br>Mid Term II<br>End Term |
| 20. | Softening of hard water, internal treatment by phosphate, calgon condition and colloid conditioning | Describe working hardness/softness of water | Lecture | 1001.3 | Class Quiz<br>Mid Term II<br>End Term |
| 21. | Numerical problems based on lime soda process. | Analyse and solve numerical problems | Lecture, Activity | 1001.3 | Class Quiz<br>Mid Term II<br>End Term |
| 22. | **Corrosion and its Control:** Introduction, significance, types of corrosion, dry corrosion. Nature of oxide layers; PB Rule | Describe corrosion and its preventions | Lecture, Activity | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 23. | Wet Corrosion: Electrochemical corrosion | Describe corrosion and its preventions | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 24. | Galvanic corrosion; Differential aeration corrosion: Pitting corrosion, Water line corrosion, Crevice corrosion. | Describe corrosion and its preventions | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 25. | Factors affecting corrosion: Nature of the metal, Nature of the Environment | Describe corrosion and its preventions | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 26. | Corrosion prevention by material selection and design alternation of environment by changing medium; Stress corrosion – Caustic embrittlement | Describe corrosion and its preventions | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 27. | Cathodic protection –sacrificial anode and impressed voltage methods, Anodic protection; Inhibitors – Anodic and Cathodic inhibitors, Protective coating – Metal coating (Electroplating, galvanization, Tinning). | Describe corrosion and its preventions | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 28. | Introduction and theory of batteries and fuel cells. | Gain knowledge of batteries | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 29. | Chemistry (working) of primary and secondary batteries. | Gain knowledge of batteries | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 30. | Working principles of fuels cells and their applications. | Gain knowledge of fuel cells | Lecture | 1001.4 | Class Quiz<br>Mid Term II<br>End Term |
| 31. | **Revision** | Recall and recap the lessons learnt during last 14 lectures | Lecture, Activity | | Class Quiz<br>Mid Term II<br>End Term |
| 32 | **The Phase Rule:** Definition, Phase rule equation, Phase, Component; Degree of freedom, examples to solve number of phase, component and degree of freedom | Gain knowledge of phase rule | Lecture | 1001.5 | Class Quiz<br>End Term |
| 33 | One component system: Water system; Sulphur system | Gain knowledge of phase rule | Lecture | 1001.5 | Class Quiz<br>End Term |
| 34 | Lead Silver system; Pattinson's process, Limitations of phase rule | Gain knowledge of phase rule | Lecture | 1001.5 | Class Quiz<br>End Term |
| 35 | **General methods of chemical analysis, Instrumental methods:** Introduction, pH metric analysis, Conductrometric analysis. Chromatographic techniques. | Gain skill in various modern analytical techniques. | Lecture | 1001.6 | Class Quiz<br>End Term |
| 36 | Paper chromatography ($R_f$ value); Thin layer chromatography; Gas Chromatography; | Gain skill in various chromatographic techniques. | Lecture | 1001.6 | Class Quiz<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 37 | Introduction to spectroscopic analysis. Beer-Lambert's law; Numerical problems. | Gain skill in various modern analytical techniques. | Lecture, Activity | 1001.6 | Class Quiz<br>End Term |
| 38 | Principle of UV visible spectroscopy. | Gain skill in analytical techniques using Uv-Vis spectroscopy. | Lecture | 1001.6 | Class Quiz<br>End Term |
| 39 | Instrumentation of UV visible spectroscopy | Gain skill in analytical techniques using Uv-Vis spectroscopy. | Lecture | 1001.6 | Class Quiz<br>End Term |
| 40 | Principle of IR (vibrational) spectroscopy. | Gain skill in analytical techniques using IR spectroscopy. | Lecture | 1001.6 | Class Quiz<br>End Term |
| 41 | Instrumentation of IR spectroscopy | Gain skill in analytical techniques using IR spectroscopy. | Lecture | 1001.6 | Class Quiz<br>End Term |
| 42 | Revision | Recall and recap the lessons learnt during the semester | Lecture, Activity | | Class Quiz<br>End Term |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| CY 1001.1 | Understand and apply concepts of various types of fuel technology. | 2 | | | | | | 3 | | | 2 | | 2 |
| CY 1001.2 | Understand the synthesis and applications of polymer and some advanced materials | | | 2 | | | | | 2 | | | | 3 |
| CY 1001.3 | Develop understanding about the water softening methods. | 2 | | | | 3 | | | | | 3 | | 2 |
| CY 1001.4 | Understand and apply the concepts in electrochemistry and corrosion science in protecting metallic objects. | | | | | | | | 2 | | | | 2 |
| CY 1001.5 | Develop concept of phase rule | | 2 | | | 2 | | | 2 | | | | 3 |
| CY 1001.6 | Understand various modern analytical techniques. | 2 | | | | 3 | | | 2 | | | | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Basic Sciences

Department of Chemistry
Course Hand-out

Environmental Studies | CY 1002 | 3 Credits | 3 0 0 3

Session: Jul 19 – Nov 19 | Co-ordinator: Dr. M. Prabhu Inbaraj | Class: B. Tech (I Semester)

**A. Introduction:** This course is offered to B. Tech. first year students for understanding the different aspects of our environment and issues related to it. The course aims at exposure to various environmental issues (regional, national and international), relevant sources of information about different issues including environmental systems and functions, environmental problems and solutions, role of public and Govt., etc. The course aims at generating useful ideas, concepts for meaningful field work in the immediate environment and self-study of books, journals, and magazines on the subject. The course introduces multi-disciplinary approach to the study of various environmental issues. The approach will facilitate participatory learning about importance of conservation, preservation and protection of the environment and striving towards a life in perfect harmony with nature.

**B. Course Outcomes:** At the end of the course, students will be able to;

**[1002.1].** Develop fundamental skills in understanding the environment, ecology and ecosystem for sustainable development saving the environment.

**[1002.2].** Apprehend environmental problems and its linkage to health and safety of society; think and act with a sense of responsibility, committing to the professional ethics.

**[1002.3].** Impart knowledge on the application of the techniques / procedures to predict / qualitatively assess the reduction in the environmental impact for sustainable development.

**[1002.4].** Promote the active involvement of oneself and society in designing the activities / processes with which the environment and ecosystem would be preserved, considering public health and safety.

**[1002.5].** Explore the impacts of various man-made activities from an environmental context. Students can demonstrate the knowledge by participating in class debates and presentations on various topics of environmental concern with effective communication.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**[PO.1]. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2]. Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3]. Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

**[PO.4]. Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

**[PO.5]. Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6]. The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

**[PO.7]. Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8]. Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9]. Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10]. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 20 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

**Environmental Studies** – Meaning, multidisciplinary nature of environmental science, applications in engineering disciplines, environmental ethics, sustainable development. **Ecology** – Types and Structure of Ecosystem. **Biodiversity** – Importance, classification, conservation methods. **Natural Resources** – Renewable and non-renewable, Resource consumption, different types of energy, Conventional sources & Non-Conventional sources of energy. **Environmental Engineering –** Environmental Pollution and control: Air / Water / Soil / Noise pollution, Water demand, Water quality standards, basics of water treatment, Conservation of water, Characteristics of sewage, treatment and disposal, Solid waste management. **Disaster Management** – meaning, natural disasters especially earthquakes & Manmade disasters. **Environmental crisis & legislations** – Global environmental problems, Environmental acts, Laws and Policies, EIA, Case studies of the past related to environmental issues, Practical activity related to environmental problems and its impacts on environment.

## F. TEXT BOOKS


T1. Rajagopalan, R., Environmental Studies; From Crisis to Cure 3rd Edition, Oxford University Press, 2016.
T2. De, A. K. and De, A. K., Environmental Studies 2nd Edition, New Age International Publishers, New Delhi, 2009.
T3. Bharucha, E., Text book of Environmental Studies for undergraduate courses 4th Edition, Universities Press, Hyderabad, 2013.


## G. REFERENCE BOOKS


R1. Tyler Miller, Jr. and Scott E. Spoolman., Environmental Science 13th Edition, Brooks/Cole, Cengage Learning, Belmont, CA, USA, 2010.
R2. Daniel B. Botkin and Edward A. Keller., Environmental Science - Earth as a Living Planet 8th Edition, John Wiley & Sons, INC. 2011.

**Lecture Plan:**

| Lec No | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | **Multidisciplinary Nature of Environmental Studies:** Scope of environmental studies, a multidisciplinary view, Importance of environmental studies | Explain the uniqueness / importance of Environmental Studies as an interdisciplinary subject | Lecture | **1002.1** | Mid Term I<br>End Term |
| 2 | **Components of the Earth:** Spheres of the earth: Atmosphere, Lithosphere, Hydrosphere, Biosphere | Recall the importance and role played by each spheres in Earth | Lecture | **1002.1** | Mid Term I<br>End Term |
| 3 | **Environmental Ethics:** systematic and critical study of practices, holistic approach | Describe the role of ethics in having concern for other creatures other than human beings, preservation and conservation of all species | Lecture | **1002.1** | Mid Term I<br>End Term |
| 4 | **Ecology**: Structure / function / components of the ecosystem | In-depth knowledge on the importance of basics in ecology | Lecture | **1002.1** | Mid Term I<br>End Term |
| 5 | **Ecosystem:** Classification, Energy transfer, Ecological pyramids | Explain ecosystem with structure, flow of energy, food chain and food webs | Lecture | **1002.1** | Mid Term I<br>End Term |
| 6 | **Bio-geochemical cycles:** Hydrological, Oxygen, Nitrogen | Explain chemical elements cycle through different ecosystems | Lecture | **1002.1** | Mid Term I<br>End Term |
| 7 | **Bio-geochemical cycles:** Carbon, Sulphur, Phosphorous | Explain chemical elements cycle through different ecosystems | Lecture | **1002.1** | Mid Term I<br>End Term |
| 8 | **Ecological succession:** Primary & Secondary | Explain the power of nature to reclaim itself without the intervention of humans | Lecture | **1002.1** | Mid Term I<br>End Term |
| 9 | **Biodiversity:** Importance and classification | Explain services provided by biodiversity, different type of biodiversity and Biogeographic zones of India | Lecture | **1002.2** | Mid Term I<br>End Term |
| 10 | **Threats to biodiversity:** Species extinction, Threatened, Invasive species | Explain biodiversity loss, biological invasive species and their impact on biodiversity | Lecture | **1002.2** | Mid Term I<br>End Term |
| 11 | **Conservation of biodiversity:** IUCN, Hotspots, CBD | Explain different measures to conserve biodiversity, description of National parks, wildlife sanctuaries etc. | Lecture | **1002.2** | In Class Quiz<br>Mid Term I<br>End Term |
| 12 | **Revision for MTE I** | Revision for preparation for mid-term exam | Lecture | NA | NA |
| 13 | **Energy Resources**: Conventional and non-conventional | Recall different energy resources including coal, oil, nuclear and their environmental impacts on the environment and on human health | Lecture | **1002.3** | Mid Term II<br>End Term |
| 14 | **Water Resources** | Explain importance of sources of water, stress on water consumption and it's conservation | Lecture | **1002.3** | Mid Term II<br>End Term |
| 15 | **Forest Resources** | Explain importance of forest resources, it's ecological role, deforestation and conservation | Lecture | **1002.3** | Mid Term II<br>End Term |
| 16 | **Land and Mineral Resources** | Explain kinds of mining, it's impact and remediation | Lecture | **1002.3** | Mid Term II<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 17 | **Energy Resources:** Conservation and Management | Explain the importance of conserving the different energy resources | Lecture | **1002.3** | Mid Term II<br>End Term |
| 18 | **Environmental pollution**: Air pollution – sources and classification of air pollutants | Recall air pollution, explain different air pollutants and their impacts on environment and human health | Lecture | **1002.3** | Mid Term II<br>End Term |
| 19 | **Air pollution control:** Source control, equipment control, diffusion | Describe control methods of air pollutants like ESP, Scrubber | Lecture | **1002.3** | Mid Term II<br>End Term |
| 20 | **Water pollution:** Sources of water pollution, classification of water pollutants | Describe water pollutants types and classifications | Lecture | **1002.3** | Mid Term II<br>End Term |
| 21 | **Water pollution:** Effects of water pollution, Water quality parameters | Explain the negative impact of water pollution on humans and environment | Lecture | **1002.3** | Mid Term II<br>End Term |
| 22 | **Wastewater treatment process:** Primary, Secondary and Tertiary | Detailed knowledge on various types / stages involved in wastewater treatment | Lecture | **1002.3** | In Class Quiz<br>Mid Term II<br>End Term |
| 23 | **Soil pollution:** Sources, effects and control of soil pollution | Explain the Causes, effects and control of soil Pollution | Lecture | **1002.3** | Mid Term II<br>End Term |
| 24 | **Noise pollution:** sources, effects and control of noise pollution | Explain the Causes, effects and control of noise Pollution | Lecture | **1002.3** | Mid Term II<br>End Term |
| 25 | **Municipal Solid-Waste Management:** sources, characteristics and control measures | Explain the Causes, effects and control of solid waste | Lecture | **1002.3** | Mid Term II<br>End Term |
| 26 | **Hazardous-Waste Management:** Land Disposal and Integrated Waste Management (3Rs) | Explain the safe disposal of hazardous wastes | Lecture | **1002.3** | Mid Term II<br>End Term |
| 27 | **Revision for MTE II** | Revision for preparation for mid-term exam | Lecture | | Mid Term II<br>End Term |
| 28 | **Disaster Management:** Natural disasters | Describe natural disasters and their impact | Lecture | **1002.4** | End Term |
| 29 | **Disaster Management:** Manmade disasters | Explain measures of man-made disaster management | Lecture | **1002.4** | End Term |
| 30 | **Global warming / Climate change:** Causes, effects and control measures | Describe global warming, climate change with its effects and control | Lecture | **1002.4** | End Term |
| 31 | **Acid rain:** Causes, effects and control measures | Describe the Acid Rain with its effects and control | Lecture | **1002.4** | End Term |
| 32 | **Ozone depletion:** Causes, effects and control measures | Explain the importance of ozone layer and causes of its depletion, control measures | Lecture | **1002.4** | End Term |
| 33 | **Environmental Laws/Acts:** Air, Water, Forest & Wildlife | Describe the provision of Water Act, 1974, Air Act, 1981 for prevention and control of water and air pollution, Explain EPA, 1986 | Lecture | **1002.4** | End Term |
| 34 | **Environmental Movements:** Chipko, Narmada dam, Silent valley, etc., | Describe different movement in India for conserving environment and their socio-economic importance | Lecture | **1002.4** | End Term |
| 35 | **International Environmental Policies:** CBD, Montreal, Kyoto | Role of international policies towards curbing the global environmental issues | Lecture | **1002.4** | End Term |
| 36 | **Environment and Human health** | Explain the inter-relationship between humans and environment | Lecture | **1002.4** | End Term |

| | | | | | |
|---|---|---|---|---|---|
| 37 | **Environmental impact assessment (EIA):** Methodology and importance | Explain the stages involved in EIA and it's importance before initiating a project | Lecture | **1002.4** | In Class Quiz<br>End Term |
| 38 | **Human Population and the Environment:** Population growth, variation among nations, Population explosion – Family Welfare Program | Explain how population expansion is directly correlated to environmental degradation | Lecture | **1002.5** | End Term |
| 39 | **Case studies of Environmental issues** | Analyse case studies from different perspective and finding solutions | Lecture | **1002.5** | End Term |
| 40 | Practical activity related to environmental problems | In-class practical activity / discussion on environmental issues | Practical | **1002.5** | End Term |
| 41 | Practical activity related to environmental problems | In-class practical activity / discussion on environmental issues | Practical | **1002.5** | End Term |
| 42 | **Revision for ETE** | Revision for preparation for end term exam | Lecture | NA | NA |
| 43 | **Revision for ETE** | Revision for preparation for end term exam | Lecture | NA | NA |

**H. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| **[1002.1].** | Apply the fundamental knowledge of environment, ecology and ecosystem to save the environment for sustainable development. | 3 | | 1 | | | 1 | 2 | | | | | 3 |
| **[1002.2].** | Apprehend environmental problems and its linkage to the health and safety of society; think and act with a sense of responsibility, committing to the professional ethics. | | 3 | | | | 3 | | 3 | 2 | | | |
| **[1002.3].** | Know the application of the technique / procedures to predict / qualitatively assess the reduction in the environmental impact for sustainable development. | 3 | 1 | | | 3 | 2 | 3 | | 1 | | | 3 |
| **[1002.4].** | Realise the active involvement of oneself and society in designing the activities / processes with which the environment and ecosystem would be preserved, considering public health and safety. | | | 1 | 1 | | | | | 3 | | | |
| **[1002.5].** | Explore the impacts of various man-made activities from an environmental context. Students can demonstrate the knowledge by participating in class debates and presentations on various topics of environmental concern with effective communication. | 2 | | | 2 | | 3 | | | | | 1 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

Faculty of Engineering

Department of Chemistry
Course Hand-out

Engineering Chemistry Laboratory| CY1030 | 1 Credit | 0 0 2 1

Session: Jul 19 – Nov 19 | Coordinator: Arunava Agarwala | Class: B.Tech. (I and II Sem)

**A. Introduction:** This course is offered by Dept. of Chemistry for all 1st year B.Tech. students. The objective of the course is to acquaint the students with the basic methods applied in chemical science laboratory relevant to engineering field.

**B. Course Objectives:** At the end of the course, students will be able to

**[1030.1].** Develop skill in quantitative chemical analysis.

**[1030.2].** Apply concept of synthetic chemistry.

**[1030.3].** Analyse physical property of materials.

**C. Program Outcomes and Program Specific Outcomes**

**[PO.1].** **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2].** **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3].** **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public healthand safety, and the cultural, societal, and environmental considerations

**[PO.4].** **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

**[PO.5].** **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6].** **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal,health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineeringpractice

**[PO.7].** **Environment and sustainability**: Understand the impact of the professional engineering solutions insocietal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8].** **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of theengineering practices

**[PO.9].** **Individual and team work**: Function effectively as an individual, and as a member or leader in diverseteams, and in multidisciplinary settings

**[PO.10].** **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11].** **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projectsand in multidisciplinary environments

**[PO.12].** **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in

independent and life-long learning in the broadest context of technological change

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Class wise assessment (Viva; Practical performance) | 60 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | A student is expected to participate and perform all the experiments with full zeal. | |

**E. Syllabus**

Alkalimetric titration; Redox titration; Estimation of total hardness of water; pK value of an acid by pH-metric titration; Conductometric acid base titrations; pH Metric acid base titrations; Synthesis of a resin; Determination of coefficient of viscosity of liquid; Determination cloud and pour point of a given sample of lubricating oil using cloud and pour point apparatus; Determine the water equivalent of bomb calorimeter using benzoic acid as fuel.

**F. Text Books**

T1. Jain P.C. and Jain M., Engineering Chemistry, Dhanpat Rai and Sons, Delhi, Revised, 15th Edn. 2006.

T2. Kuriacose J.C., Raja R. J., Chemistry in Engineering and Technology, Vol. I/II TMH 1988

**G. Reference Books**

*No Reference books required for this course.*

**H. Lecture Plan:**

| Lec No | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1. | Determination of trength of given unknown ferrous ammonium sulphate solution by titrating against standard $K_2Cr_2O_7$ using diphenylamine as an internal indicator | Develop skill in quantitative chemical analysis. | Activity | 1030.1 | Practical Assessments and End Term Lab Assessment |
| 2. | Determination of strength of given unknown ferrous ammonium sulphate solution by titrating against standard $K_2Cr_2O_7$ using potassium ferricyanide as an external indicator. | Develop skill in quantitative chemical analysis. | Activity | 1030.1 | Practical Assessments and End Term Lab Assessment |
| 3. | Determination of the total, permanent and temporary hardness of given water sample by complexometric titration using EDTA solution | Develop skill in quantitative chemical analysis. | Activity | 1030.1 | Practical Assessments and End Term Lab Assessment |
| 4. | Determination of the strength of sodium carbonate and sodium hydroxide in given alkali mix. (water sample) hydrochloric acid is used as an intermediate solution, methyl orange and phenolphthalein used as indicators | Develop skill in quantitative chemical analysis. | Activity | 1030.1 | Practical Assessments and End Term Lab Assessment |
| 5. | Determination of the strength of ferrous Ammonium Sulphate by titrating against $KMnO_4$ solution | Develop skill in quantitative chemical analysis. | Activity | 1030.1 | Practical Assessments and End Term Lab Assessment |
| 6. | Preparation of urea formaldehyde resin | Apply concept of synthetic chemistry. | Activity | 1030.2 | Practical Assessments and End Term Lab Assessment |
| 7. | Determination of strength of given HCl solution using a standard NaOH solution by performing a pH-metric titration. | Analyse physical property of materials | Activity | 1030.1 | Practical Assessments and End Term Lab Assessment |
| 8. | Determination of strength of given HCl solution using a standard NaOH solution by performing a conductometric titration. | Analyse physical property of materials | Activity | 1030.1 | Practical Assessments and End Term Lab Assessment |
| 9. | Determination of strength of given $CH_3COOH$ solution using a standard NaOH solution by performing a pH-metric titration. | Analyse physical property of materials | Activity | 1030.1 | Practical Assessments and End Term Lab Assessment |
| 10. | Determination of $pK_{a1}$ and $pK_{a2}$ of phosphoric acid. | Analyse physical property of materials | Activity | 1001.3 | Practical Assessments and End Term Lab Assessment |
| 11. | Titration of a mixture of strong acid HCl and weak acid $CH_3COOH$ and determine the | Analyse physical property of materials | Activity | 1001.3 | Practical Assessments and End Term Lab Assessment |

| | | | | | |
|---|---|---|---|---|---|
| | Determination of unknown strength of HCl and $CH_3COOH$ pH-metrically | | | | |
| 12. | the equivalent conductance of given an electrolyte | Analyse physical property of materials | Activity | 1001.3 | Practical Assessments and End Term Lab Assessment |
| 13. | Determination of the viscosity of a given lubricating oil at various temperatures using Redwood Viscometer No. 1 or No. 2. / Determination of cloud and pour point of a given sample of lubricating oil using cloud and pour point apparatus | Analyse physical property of materials | Activity | 1001.3 | Practical Assessments and End Term Lab Assessment |
| 14. | Demonstration of working of bomb calorimeter. | Analyse physical property of materials | Activity | 1001.3 | Practical Assessments and End Term Lab Assessment |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| CY 1030.1 | Develop skill in quantitative chemical analysis. | 2 | | | | | | 3 | | | 2 | | 2 |
| CY 1030.2 | Apply concept of synthetic chemistry. | | | 2 | | | | | 2 | | | | 3 |
| CY 1030.3 | Analyse physical property of materials. | 2 | | | | 3 | | | | | 3 | | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Electrical Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Basic Electronics| EC 1001 | 3 Credits | 2 1 0 3

Session: July 19 – Nov 19 | Faculty: Vishal Das | Class: Core Subject

## A. Introduction:

The growth of mobile telephony, broadband and wireless internet has led to the growth of career opportunities in the field of communication engineering. This course is a basic overview of electronic components and their common uses. It covers the characteristics and applications of analog and digital circuit components. Emphasis is placed on analysis, selection and applications. The coverage is not as deep as an electronics course aimed at electrical engineers. There are a number of physical applications demonstrated in this course that serve to motivate a wider audience. The course is ideal for someone who wants to gain a basic understanding of electrical circuits, hobbyists, or for someone who is considering electrical engineering as a career.

Review of physics, introduction to semiconductor devices: diodes and transistors. Equivalent circuits and models of semiconductor devices. DC biasing circuits for transistors. Analysis and design of transistor amplifiers. Operational amplifier systems. Number System, Boolean Algebra, Specification and implementation of combinational and sequential systems. Introduction to basic electronic communication systems.

## B. Course Outcomes:

**B. Course Outcomes:** At the end of the course, students will be able to:

**[EC1001.1].** Apply principles of physics to describe and analyse the working of semiconductor devices and integrated circuits and hence develop employability skills.

**[EC1001.2].** Analyse different biasing configurations of Bipolar Junction Transistor

**[EC1001.3].** Analyse Inverting or Non-Inverting amplifier structures comprising of Operational Amplifier and to promote development of skills towards core employability

**[EC1001.4].** Demonstrate inter-conversion on different number systems

**[EC1001.5].** Demonstrate minimization of Boolean expressions

**[EC1001.6].** Identify different elements of communication

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**[PO.1]. Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

**[PO.2]. Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**[PO.3]. Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

**[PO.4]. Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

**[PO.5]. Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6]. The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

**[PO.7]. Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8]. Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9]. Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10]. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I | 20 |
| | Sessional Exam II | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 20 |
| End Term Exam (Summative) | End Term Exam | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

PN Junction: Formation of depletion region, Effect of forward and reverse bias on depletion region, I-V characteristics and equivalent circuits of ideal and practical diode, Diode equation. Application of Diode: Series and parallel combination of diodes circuits, Half Wave and Full Wave rectifiers, capacitor filter, clipper, clamper circuits, Zener Diode; I-V Characteristics, Zener Regulators. BJT: Construction, schematic diagram and characteristic of CE, CB Configuration, CC configuration w.r.t. CE, Relation between α and β, transistor biasing, Q-point, load line, fixed bias, self-bias. Operational Amplifier: Ideal characteristics of an Op. Amp., Inverting and Non-inverting, amplifiers, Linear Circuit applications as voltage follower, integrator, differentiator, summing amplifier, subtractor. Digital Electronics: Number systems, Boolean algebra, De Morgan's Theorem, logic gates; Truth tables, SOP, POS form, K-map for minimization of Boolean expressions, Implementation of Boolean expressions with logic gates, Introduction to combinational & sequential circuits. Communication Systems: Elements of communication systems, Analog modulation scheme.

## TEXT BOOKS


1. R. L. Boylestad, L. Nashelsky, Electronic Devices and Circuit Theory, (10e), Pearson, 2009.
2. S. Salivahanan, S. Arivazhagan, Digital circuits and Design, (5e), Oxford University Press, 2018.
3. G. Kennedy, B. Davis, S R M Prasanna, Electronic Communication systems, (6e), Mcgraw Hill, 2017.
4. V. K. Mehta, Rohit Mehta, Principles of Electronics, (10e), S. Chand Publication, 2006.
5. B. L. Thereja, Basic Electronics: Solid state, (5e), S. Chand Publication, 2005.


## H. Lecture Plan:

| LEC NO. | TOPICS | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Overview of Semiconductors | Recall concept of Semiconductors | | EC1001.1 (CO 1) | NA |
| 2 | Introduction to Extrinsic Semiconductors | Understanding of Doping | Lecture | EC1001.1 (CO 1) | In Class Quiz |
| 3 | Introduction to PN junction diode, Formation of depletion region | Understanding of switches | Lecture | EC1001.1 (CO 1) | In Class Quiz |
| 4 | Forward and reverse bias, I-V Characteristics | Understanding of switch operation and their characteristics | Lecture | EC1001.1 (CO 1) | In Class Quiz<br>Mid Term I |
| 5, 6 | Equivalent circuits of ideal and practical diode | Model of the diode for circuits | Lecture | EC1001.1 (CO 1) | In Class Quiz |
| 7 | Diode equation | Introduction to the drift and diffusion in diode equation. | Lecture | EC1001.1 (CO 1) | In Class Quiz<br>Mid Term I<br>End Term |
| 8-10 | Application to Diodes: Series and Parallel combination of diode circuits | Use of switches to get different function in electrical circuits | Lecture | EC1001.1 (CO 1) | In Class Quiz<br>Mid Term I<br>End Term |
| 11 | Half and Full wave rectifiers | Introduction to pulsating D.C | Lecture | EC1001.1 (CO 1) | In Class Quiz<br>Mid Term I<br>End Term |
| 12 | Capacitor Filter | Introduction to Filters | Lecture | EC1001.1 (CO 1) | |
| 13-14 | Clipper circuits | Understanding of wave shaping circuits | Lecture | EC1001.1 (CO 1) | In Class Quiz<br>Mid Term I<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 15 | Clamper circuits | Understanding of wave shaping circuits | Lecture | EC1001.1 (CO 1) | In Class Quiz<br>Mid Term I<br>End Term |
| 16 | Zener diode and its I-V characteristics | Understanding of voltage regulating device. | Lecture | EC1001.1 (CO 1) | In Class Quiz |
| 17-18 | Zener regulators | Understanding of voltage regulating circuits | Lecture | EC1001.1 (CO 1) | In Class Quiz<br>Mid Term I<br>End Term |
| 19 | Tutorial | | | | |
| 20 | Introduction to BJT | Understanding of three terminal devices | Lecture | EC1001.2 (CO 2) | In Class Quiz |
| 21 | Operation of BJT | Understanding of minority carrier movement | Lecture | EC1001.2 (CO 2) | In Class Quiz |
| 22 | Transistor configuration: symbolic representation and CB Characteristics. | Characteristics of BJT under various config. | Lecture | EC1001.2 (CO 2) | In Class Quiz<br>Mid Term II<br>End Term |
| 23 | Transistor configuration: symbolic representation and CE Characteristics | Characteristics of BJT under various config. | Lecture | EC1001.2 (CO 2) | In Class Quiz<br>Mid Term II<br>End Term |
| 24 | CC configuration w.r.t. CE, Relation between $\alpha$ and $\beta$ | Characteristics of BJT under various config. | Lecture | EC1001.2 (CO 2) | In Class Quiz<br>Mid Term II<br>End Term |
| 25 | Transistor Biasing, Q-point, Load line | Effect of load on the characteristics | Lecture | EC1001.2 (CO 2) | In Class Quiz<br>Mid Term II<br>End Term |
| 26 | Fixed biasing | Effect of load on the characteristics | Lecture | EC1001.2 (CO 2) | In Class Quiz<br>Mid Term II<br>End Term |
| 27 | Self-biasing | Effect of load on the characteristics | Lecture | EC1001.2 (CO 2) | In Class Quiz<br>Mid Term II<br>End Term |
| 28 | Introduction to Operational Amplifier, Op. Amp Characteristics. | Understanding the OPAMP characteristics and its difference from BJT as an amplifier. | Lecture | EC1001.3 (CO 3) | In Class Quiz |
| 29 | Inverting amplifier | Application of OPAMP | Lecture | EC1001.3 (CO 3) | In Class Quiz<br>Mid Term II<br>End Term |
| 30 | NON-Inverting amplifier, Linear applications of Op. Amp as voltage follower | Application of OPAMP | Lecture | EC1001.3 (CO 3) | In Class Quiz<br>Mid Term II<br>End Term |
| 31 | Summing amplifier, Subtractor | Application of OPAMP | Lecture | EC1001.3 (CO 3) | In Class Quiz<br>Mid Term II<br>End Term |
| 32 | Integrator, Differentiator | Application of OPAMP | Lecture | EC1001.3 (CO 3) | In Class Quiz<br>Mid Term II<br>End Term |
| 33 | Tutorial | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 34 | Digital Electronics: Number system | Mathematical understanding of Number System | Lecture | EC1001.4 (CO 4) | In Class Quiz |
| 35 | Boolean algebra, DeMorgan's theorem | Understanding the Algebra in Digital Electronics | Lecture | EC1001.5 (CO 5) | In Class Quiz End Term |
| 36 | Logic gates, Truth table. | Basic entities of Digital Electronics | Lecture | EC1001.5 (CO 5) | In Class Quiz End Term |
| 37 | Implementation of Boolean expression with logic gates | Use of Logic Gates to implement any Logic in Digital | Lecture | EC1001.5 (CO 5) | In Class Quiz End Term |
| 38 | SOP, POS forms | Understanding of various forms to represent a Logic | Lecture | EC1001.5 (CO 5) | In Class Quiz End Term |
| 39 | K-Map for minimization of Boolean expressions | A systematic way to minimize the given logic | Lecture | EC1001.5 (CO 5) | In Class Quiz End Term |
| 40 | S-R Flip Flop | Understanding of Basic Sequential Circuits | Lecture | EC1001.5 (CO 5) | In Class Quiz End Term |
| 41 | Introduction to communication system & Analog Modulation Scheme | Basic concept of Communication | Lecture | EC1001.6 (CO 6) | In Class Quiz End Term |
| 42 | Tutorial | | | | |

## I. Course Articulation Matrix: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| **[EC1101.1]** | Apply principles of physics to describe and analyse the working of semiconductor devices and integrated circuits | 3 | 2 | 3 | 1 | | | 1 | | | | | 1 |
| **[EC1101.2]** | Analyse different biasing configurations of bipolar junction transistor | 3 | 2 | 1 | 2 | 1 | | | | | | | **1** |
| **[EC1101.3]** | Analyse inverting or non-inverting amplifier structures comprising of operational amplifiers | 3 | 3 | 3 | 2 | **2** | | | | | | | 1 |
| **[EC1101.4]** | Demonstrate interconversion on different number systems | 3 | 2 | 3 | 2 | **2** | | 1 | | | | | 1 |
| **[EC1101.5]** | Demonstrate minimization of Boolean expressions | **3** | 3 | 1 | **2** | **2** | | | | | | | 1 |
| **[EC1101.6]** | Identify different elements of communication | **3** | 2 | **2** | 2 | | 1 | | | | | | 2 |

# MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics and Communication

Department of Electrical Engineering
Course Hand-out

Basic Electrical Technology | EE 1001 | 4 Credits | 2 1 0 3

Session: Jan. 20 – Apr. 20 | Faculty: Dr. Manish Kumar Thukral | Class: First Year (All Branches)

**A. Introduction:** This course is offered by Dept. of Electrical Engineering as a basic fundamental subject to impart essential knowledge and information of Electrical Technology and their applications. The learning objective would cover the following aspects: -

a) To develop circuit designing skills through general insight of circuit laws and theorems.
b) To analyse the magnetic & electric circuit and calculate different parameters
c) To develop and analyse the single and three phase circuits.
d) To understand the concepts of basic construction & operation of transformer.
e) To understand the fundamentals of DC & Induction motors and measuring Instruments.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1001.1].** Recall basic circuit laws and apply theorems to analyse different types of DC circuits.
**[1001.2].** Understand and apply the basic concepts of electromagnetism.
**[1001.3].** Identify and evaluate different configurations of single phase & three phase ac circuits.
**[1001.4].** Understand and apply the construction and operating principle of transformer.
**[1001.5].** Illustrate the basic operating principles of DC machines & Induction motors and fundamental measuring Instruments

**C. Program Outcomes and Program Specific Outcomes**

**[PO.1].Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2].Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3].Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

**[PO.4].Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

**[PO.5].Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6].The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

**[PO.7].Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8].Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9].Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10]. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## D. Assessment Rubrics:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 20 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. Syllabus

DC circuits, Independent sources, Resistance, Network reduction techniques, Mesh and Node voltage analysis, Superposition, Thevenin's and Maximum power transfer theorems, Transient behaviour of inductance and capacitance, Self and Mutual inductances, Coupled coils, Dot rule, Average and RMS values of sinusoidal waves, Series and Parallel AC circuits, Phasor Analysis, Power factor improvement, Series and Parallel resonance, Three phase star and delta connected loads, Measurement of power in three phase circuits, Electrical power system, Emf Equation, Construction & Types of Transformers, DC motors, BLDC, Induction motors, Synchronous motors, Stepper motors, Fundamentals of Electrical Measuring Instruments.

## F. TEXT BOOKS


1. Nagasarkar & Sukhija, Basic Electrical Engineering, Oxford University Press, 2006.
2. S.K. Sahdev, Fundamentals of Electrical Engineering & Electronics, Dhanpat Rai & Co, 2010.
3. D. C. Kulsheshtha, Basic Electrical Engineering, McGraw Hill Education India, 2011.


## G. REFERENCE BOOKS


1. S. N. Singh, Basic Electrical Engineering, PHI, 2011.
2. D. P. Kothari. & I. J. Nagarath, Basic Electrical Technology, TMH 2004.

**H. Lecture Plan:**

| Lec No | **Topics** | **Session Outcomes** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| L1 | Introduction to the Course | To acquaint students with the outcome based education (OBE) and Course outcome (CO) and program outcome (PO) assessment process | Lecture | | NA |
| L2 | Basic circuit elements, Source Transformation | Recall the basic elements of a DC network | Lecture | [1001.1] | Class Quiz |
| L3 | Series & parallel resistive circuits, Review of Kirchhoff's laws | Identify different series and parallel network configurations and their equivalent resistance calculation | Lecture | [1001.1] | Home Assignment<br>Class Quiz |
| L4-L5 | Star-Delta transformation | Explain the need of star-delta transformation and their applications | Lecture | [1001.1] | Home Assignment<br>Class Quiz |
| T1 | L1 – L5 | Numerical problems based on L1-L5 | Tutorial | [1001.1] | Mid Term Exam |
| L6 – L7 | DC Circuit Analysis – Mesh & Node analysis methods | Recall KVL and KCL and apply them to find solution of different dc network problems using Mesh & Node analysis methods | Lecture | [1001.1] | Mid Term Exam |
| T2-T3 | L6 – L7 | Numerical problems based on L6-L7 | Tutorial | [1001.1] | Mid Term Exam |
| L8-L11 | DC Network Theorems: Superposition, Thevenin, Norton, Maximum Power Transfer | Analyze and solve different dc network problems using all mentioned theorems | Lecture | [1001.1] | Home Assignment<br>Class Quiz<br>Mid Term Exam |
| T4-T5 | L8-L11 | Numerical problems based on L8-L11 | Tutorial | [1001.1] | Mid Term Exam |
| L12 | Capacitor, Series & Parallel connections, Charging & Discharging, Energy stored | Recall series and parallel connection of capacitors and energy stored | Lecture | [1001.2] | Class Quiz |
| L13 | Inductor, Series & parallel connections, Growth & Decay of current in inductive circuit, Energy Stored | Recall series and parallel connection of inductors and energy stored | Lecture | [1001.2] | Class Quiz |
| T6 | L12 – L13 | Numerical problems based on L12-L13 | Tutorial | [1001.2] | Class Quiz |
| L14– L15 | Magnetic circuits, Terminologies, Analysis of series and parallel circuits | Recall the concept of magnetic circuits and their configurations | Lecture | [1001.2] | Class Quiz |
| L16 | Review of Electromagnetism, Electromagnetic Induction, Fleming's left & right hand rules, Lenz's Law | Recall the Fleming's rule, Lenz's law, Faraday's law and review the concept of Electromagnetism | Lecture | [1001.2] | Class Quiz |
| L17– L18 | Induced emf in a conductor & coil, Mutual Inductance, Coupling Coefficient and dot rule | Describe the concept of emf induced in coil, dot rule and Coupling Coefficient | Lecture | [1001.2] | Class Quiz |
| T7-T8 | L14– L18 | Numerical problems based on L14-L18 | Tutorial | | Class Quiz |
| L19-L20 | Single phase circuits: Generation, Emf induced, Average value, RMS value, Peak factor, Form factor | Describe the concept of generation of ac voltage and waveform analysis | Lecture | [1001.3] | Class Quiz |

| | | | | | |
|---|---|---|---|---|---|
| L21 – L24 | Phasors, Analysis of pure R, L, C, Series RL, RC and RLC circuits, Impedance, Power, Power factor | Describe the phasor operations and calculation of different quantities pertaining to different combinations of series ac circuits | Lecture | [1001.3] | Mid Term Exam |
| L25-L26 | Analysis of Parallel RL, RC and RLC circuits | Analyze and calculate different quantities pertaining to parallel ac circuits | Lecture | [1001.3] | Mid Term Exam |
| T9-T10 | L19 – L26 | Numerical problems based on L19-L26 | Tutorial | [1001.3] | Mid Term Exam |
| L27 – L28 | Series & Parallel Resonance, Resonant frequency, Voltage & Current magnification | Recall and examine the series and parallel resonance phenomenon | Lecture | [1001.3] | Class Quiz |
| T11 | L27– L28 | Numerical problems based on L27-L28 | Tutorial | [1001.3] | Class Quiz |
| L29-L30 | Three phase ac circuits, Advantages, Types of connections, Voltage & Currents, Line & Phase values | Identify and analyse different types of Three phase ac circuits | Lecture | [1001.3] | Class Quiz |
| L31-L32 | Analysis of balanced 3 wire & 4 wire star and delta connected systems, Phasor diagrams | Analyze three phase balanced star and delta connected systems | Lecture | [1001.3] | Mid Term Exam |
| L33 | Measurement of three phase power by two wattmeter method | Examine two wattmeter method for three phase power Measurement | Lecture | [1001.3] | Mid Term Exam |
| T12-T13 | L29 – L33 | Numerical problems based on L29-L33 | Tutorial | [1001.3] | Class Quiz |
| L34 | Single phase transformer: Introduction, types, Construction, Operating principle, Emf equation | Recall and analyse operating principle of Single phase transformer and their types | Lecture | [1001.4] | Class Quiz |
| L35 – L36 | Ideal & practical transformer, Losses and Efficiency, Voltage regulation | Compare the ideal and practical transformer and analyse different performance parameters | Lecture | [1001.4] | Mid Term Exam |
| T14 | L34 – L36 | Numerical problems based on L34-L36 | Tutorial | [1001.4] | Class Quiz |
| L37 - L38 | Introduction of single and three phase induction motors | Describe the operating principle of single and three phase induction motors | Lecture | [1001.5] | Class Quiz |
| L39-L40 | DC Machine: Introduction, Construction, Types | Describe the construction and operating principle of DC machine | Lecture | [1001.5] | Class Quiz |
| L41-L42 | Fundamentals of Electrical Measuring Instruments | Describe the construction and operating principle of different Measuring Instruments | Lecture | [1001.5] | Class Quiz |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| EE 1001.1 | Develop circuit designing skills through general insight of circuit laws and theorems. | 3 | 2 | | | | | | | | | | 2 |
| EE 1001.2 | Understand the basic concepts of electromagnetism | 2 | 1 | | | | | | | | | | 2 |
| EE 1001.3 | Identify and evaluate different configurations of single phase & three phase ac circuits. | 1 | 2 | | | | | | | | | | 3 |
| EE 1001.4 | Understand the construction and operating principle of transformer and evaluate efficiency. | 2 | 2 | 1 | | | 1 | 1 | | | | | 2 |
| EE 1001.5 | Illustrate the basic operating principles of DC & Induction motors and fundamental measuring Instruments. | | | | | | 1 | 1 | | | | | |

**1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Humanities and Social Sciences

## DEPARTMENT OF LANGUAGES

Course Hand-out

Communication Skills in English | LN 1001 | 2 Credits | 2 0 0 2

Session: Jan - Apr 20 | Faculty: Dr Arun Kumar Poonia| Class: B-Tech I Semester

**A.** **Introduction:** This course is offered by the Department of Languages as a common course to the students of B. Tech in Semester-I/II. The course offers an in-depth knowledge of language as an important branch of English language studies. It covers basic concepts such as role of communication, vocabulary, comprehension, composition, and presentation skills. It also focuses on the enhancement of critical thinking, reasoning abilities, active listening, proper and appropriate writing skills in various practical situations.

**B.** **Course Outcomes:** At the end of the course, students will be able to

**[LN1001.1]** Apply the fundamental principles of effective communication in day to day life as well as in the professional world.

**[LN1001.2]** Develop critical and creative thinking abilities for communicative competence

**[LN1001.3]** Organize and express ideas clearly in speech

**[LN1001.4]** Develop ideas with precision and coherence in writing

**[LN1001.5]** Utilize analytical communicative skills for effective presentations during employment opportunities and later on working in a team.

**C.** **PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

**[PO.1].** **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

**[PO.2].** **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**[PO.3].** **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

**[PO.4].** **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**[PO.5].** **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**[PO.6].** **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**[PO.7]. Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**[PO.8]. Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

**[PO.9]. Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**[PO.10]. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | CWS (In class Assignments & 3 Quizzes- Best2 Assignments & Quizzes will be counted) | 10+10=20 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work at home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

**Communication:** Definition, process, features, types, modes, and barriers; **LSRW Skills- Listening:** Listening to groups and individuals- active listening, response, and feedback; comprehending conversations and lectures; **Reading:** Analysis of passages; skimming and scanning; contextual meaning; advanced vocabulary; **Writing**: Paragraph writing; Writing Creative and Critical responses; Formal letters; Emails; Résumés; Statement of Purpose; **Speaking:** Presentation, Discussion, and Debate on current affairs, scientific enquiry, philosophical attributions, literary sensibilities, socio-political awareness, and cultural sensitivity; Telephonic Etiquettes; Role Play; Team Work; Time Management; Grooming; Exploring multiple perspectives- critical reasoning, constructive feedback, persuasive arguments, and effective interpersonal communication.

## F. REFERENCES:


1) Meenakshi Raman and S. Sharma, Technical Communication: Principles and Practice, (2/e), Oxford University Press, 2013.
2) N. Krishnaswamy, Modern English: A Book of Grammar Usage and Composition, Macmillan India, 2018.
3) Sanjay Kumar and Pushplata, Communication Skills, Oxford University Press, 2016.
4) Sunita Mishra and C. Muralikrishna, Communication Skills for Engineers, Pearson, 2014.


## G. Lecture Plan:

| DAY | TOPICS | Programme objective | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| Day 1 | Introduction about the course hand-out/ Examination scheme/Internal Assessment and Communication skills. | Review communication as a process with greater awareness | Lecture, PPT, Discussion | 1001.1 | Quizzes, I Sessional, End Term Examination |
| Day 2 & 3 | Definition, process, features, types, modes, and barriers | Display enhanced competence in oral communication | Lecture, PPT, Discussion | 1001.1, 1001.2 | Quizzes, I Sessional, End Term Examination |
| Day 4 & 5 | LSRW Skills- Listening: Listening to groups and individuals- active listening, response, and feedback | Display enhanced competence in oral and written communication | Lecture, PPT, Discussion | 1001.1, 1001.2 | Quizzes, I Sessional, End Term Examination |

| | | | | | |
|---|---|---|---|---|---|
| Day 6 | Comprehending conversations and lectures | Use appropriate co mmunication skills in specific contexts and for specific purposes | Lecture, PPT, Discussion | 1001.1, 1001.2 | Quizzes, I Sessional, End Term Examination |
| Day 7& 8 | **Reading:** Analysis of passages; skimming and scanning; contextual meaning | Use appropriate co mmunication skills in specific contexts and for specific purposes | Lecture, PPT, Discussion | 1001.1, 1001.2 | Quizzes, II Sessional, End Term Examination |
| Day 9 | Advanced vocabulary | Demonstrate meaningful group communication exchanges | Lecture, PPT, Discussion | 1001.2, 1001.3, 1001.4 | Quizzes, II Sessional, End Term Examination |
| Day 10 | **Writing**: Paragraph writing; Writing Creative and Critical responses | Develop critical and creative thinking abilities for communicative competence | Lecture, PPT, Discussion | 1001.1, 1001.2, 1001.4 | Quizzes, II Sessional, End Term Examination |
| Day 11 & 12 | Formal letters; Emails | Develop critical and creative thinking abilities for communicative competence | Lecture, PPT, Discussion | 1001.1, 1001.2, 1001.4 | Quizzes, II Sessional, End Term Examination |
| Day 13 & 14 | Resume and Statement of Purpose | Develop critical and creative thinking abilities for communicative competence | Lecture, PPT, Discussion | 1001.1, 1001.2, 1001.4 | Quizzes, II Sessional, End Term Examination |

| | | | | | |
|---|---|---|---|---|---|
| Day 15 | **Speaking:** Presentation Skills and discussion. | Use appropriate co mmunication skills in specific contexts and for specific purposes | Lecture, PPT, Discussion | 1001.1, 1001.2, 1001.3, 1001.5 | Quizzes, End Term Examination |
| Day 16-18 | Debate on current affairs, scientific enquiry, philosophical attributions, literary sensibilities, socio-political awareness, and cultural sensitivity | Use appropriate co mmunication skills in specific contexts and for specific purposes | Lecture, Discussion and any case study | 1001.1, 1001.2, 1001.3 | Quizzes |
| Day 19 | Telephonic Etiquettes | Use appropriate co mmunication skills in specific contexts and for specific purposes | Lecture, PPT, Discussion | 1001.1, 1001.3 | Quizzes, End Term Examination |
| Day 20 & 21 | Role Play and Team Work | Use appropriate co mmunication skills in specific contexts and for specific purposes | Lecture, PPT, Discussion | 1001.1, 1001.5 | Quizzes |
| Day 22 & 23 | Time Management and grooming | Develop critical and creative thinking abilities | Lecture and Discussion | 1001.1, 1001.3, 1001.5 | Quizzes |
| Day24-26 | Exploring multiple perspectives- critical reasoning, constructive feedback, persuasive arguments | Develop critical and creative thinking abilities | Lecture, PPT, Discussion, any case study | 1001.1, 1001.2, 1001.3 | Quizzes |
| Day 27 & 28 | Effective interpersonal communication | Use appropriate co mmunication skills in specific contexts and for specific purposes | Lecture, PPT, Discussion, any case study | 1001.1, 1001.3, 1001.5 | Quizzes |

**H. Course Articulation Matrix: (Mapping of COs with POs & PSOs)**

| CO | STATEMENT | Correlation with Program Outcomes **(POs)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **[LN1001.1]** | Apply the fundamental principles of effective communication in day to day life as well as in the professional world | | | | | | **1** | | **2** | **1** | **1** | | |
| **[LN1001.2]** | Develop critical and creative thinking abilities for communicative competence | | **1** | | | | **1** | | **1** | | | | |
| **[LN1001.3]** | Organize and express ideas clearly in speech | | | | | | | | | **1** | **1** | | |
| **[LN1001.4]** | Develop ideas with precision and coherence in writing | | **1** | | | | | | | | **1** | | |
| **[LN1001.5]** | Utilize analytical communicative skills for effective presentations and team work | | | | | | **1** | | **1** | **2** | **2** | **1** | |

**1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Engineering

Department of Mathematics & Statistics
Course Hand-out

Engineering Mathematics-I | MA 1101 | 4 Credits | 3 1 0 4

Session: Jan 20 – Apr 20 | **Dr Sunil Joshi** | Class: Ist Year

**A. Introduction:** An engineering student needs to have some basic mathematical tools and techniques which emphasize the development of rigorous logical thinking and analytical skills. Based on this, the course aims at giving adequate exposure to the theory and applications. The course is aimed at developing the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering

**B. Course Outcomes:** At the end of the course, students will be able to

**[MA1101.1]** To describe the concept of ODE and their applications to solve the problems

**[MA1101.2]** To describe the concept of Interpolation, Numerical differentiation & integration and their applications and in real life problems.

**[MA1101.3]** To Describe the concept of numerical methods to evaluate the roots of Algebraic & Transcendental equations and solutions of ODE though which one could develop programming skills to develop the skill of solving the complex problems which intern become employable in corporate sector

**[MA1101.4]** To Describe the concept of rank for the matrix by solution of the system of linear equations and developed their skill to solve engineering application based problems.

**[MA1101.5]** To Describe the basic concepts of vector space and to analysis the problems having engineering applications.

**C. Program Outcomes and Program Specific Outcomes**

**[PO.1].** **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**[PO.2].** **Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences**.**

**[PO.3].** **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

**[PO.4].** **Conduct investigations** of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions**.**

**[PO.5].** **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an under- standing of the limitations.

**[PO.6].** **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

**[PO.7].** **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

**[PO.8].** **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice**.**

**[PO.9].** **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

**[PO.10].** **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions**.**

**[PO.11].** **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to owners own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**[PO.12].** **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | Quizzes (Open Book/Close Book) and Assignments | 20 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. A student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. Syllabus

Matrices-inverse and rank, solution of linear system of equations, Eigen value problems. Vector spaces, basis, linear transformations, inner product spaces and Orthogonalization. First and higher order differential equations and their solutions; finite difference and interpolation for equal and unequal intervals, Numerical differentiation and integration. Solution of algebraic and transcendental equations, solutions of ordinary differential equations.

## F. Text Book:

1. Grewal B. S., *Higher Engineering Mathematics*, (42e), Khanna Publishers, 2013

## G. Reference Book:

1. Kreyszig E., Advanced *Engineering Mathematics*, (10e), Wiley Eastern, 2011
2. Lay David C., *Linear Algebra and applications*, (3e), Pearson Education, 2009
3. Sastry S. S., *Introductory methods of Numerical analysis*, (4e), PHI, 2007

4. Iyengar S.R.K. and Jain, Rajendra K., *Advance Engineering Mathematics (3e)*, Narosa book distributors Pvt Ltd-New Delhi, 2007
5. Ramana B. V., *Higher Engineering Mathematics* (6th reprint), Tata Mcgraw-Hill, New Delhi, 2008

**H. Lecture Plan:**

| Lecture No. | Description of the Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introduction: Basic definitions, solving first order differential equations using Variable separable method. | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 2 | Homogeneous | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 3 | reducible to Homogeneous | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 4 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 5 | Linear D. E | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 6 | Bernouli equations | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 7 | Solution of Exact differential equations | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 8 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |

| | | | | | |
|---|---|---|---|---|---|
| 9 | Reducible to exact methods | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 10 | higher order differetial equations - finding CF | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 11 | Inverse differential operator method to calculate P.I for eax , sin (ax+b) and cos (ax+b) | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 12 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 13 | Inverse differential operator method to calculate P.I for xm, eax v | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 14 | P.I using method of variation of parameters | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.1 | Quizzes, assignments, Two Sessional, End Term Examination |
| 15 | Finite difference operators and relation among them. | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 16 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 17 | Newton-Gregory forward and backward interpolations | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 18 | Stirlings formula | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |

| | | | | | |
|---|---|---|---|---|---|
| 19 | Lagrange's and inverse interpolation for unequal intervals. | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 20 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 21 | Numerical Differentiation - forward and backward formulas | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 22 | Numerical Differentiation - Central formula | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 23 | Numerical differentiation for unequal intervals | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 24 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 25 | Numerical Integration- Newton Cotes formula | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 26 | Trapezoidal and Simpson's 1/3 rd rules of integration | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 27 | Simpson's 3/8 th rule of integration,Weddle rule | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |
| 28 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.2 | Quizzes, assignments, Two Sessional, End Term Examination |

| | | | | | |
|---|---|---|---|---|---|
| 29 | Solution of algebraic and transcendental equations : Bisection method | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.3 | Quizzes, assignments, Two Sessional, End Term Examination |
| 30 | Regula –Falsi method | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.3 | Quizzes, assignments, Two Sessional, End Term Examination |
| 31 | Solution by Newton Raphson's method | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.3 | Quizzes, assignments, Two Sessional, End Term Examination |
| 32 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.3 | Quizzes, assignments, Two Sessional, End Term Examination |
| 33 | Numerical solution of ordinary differential equations- by Taylor series method | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.3 | Quizzes, assignments, Two Sessional, End Term Examination |
| 34 | Numerical solution of ordinary differential equations- by Euler 's method and modified Euler's method | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.3 | Quizzes, assignments, Two Sessional, End Term Examination |
| 35 | Runge-Kutta method order 4 | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.3 | Quizzes, assignments, Two Sessional, End Term Examination |
| 36 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.3 | Quizzes, assignments, Two Sessional, End Term Examination |
| 37 | Matrices and their properties, Elementary row transformations and Echelon matrix | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.4 | Quizzes, assignments, Two Sessional, End Term Examination |
| 38 | Rank of the matrix with problems | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.4 | Quizzes, assignments, Two Sessional, End Term Examination |

| | | | | | |
|---|---|---|---|---|---|
| 39 | Consistency of the system of homogeneous/non homogeneous equations: Solution by Gauss elimination | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.4 | Quizzes, assignments, Two Sessional, End Term Examination |
| 40 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.4 | Quizzes, assignments, Two Sessional, End Term Examination |
| 41 | Gauss Jordan method for inverse evaluation, examples | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.4 | Quizzes, assignments, Two Sessional, End Term Examination |
| 42 | Iterative method for solving system of equations: Gauss Jacobi method | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.4 | Quizzes, assignments, Two Sessional, End Term Examination |
| 43 | Gauss Seidel method | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.4 | Quizzes, assignments, Two Sessional, End Term Examination |
| 44 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.4 | Quizzes, assignments, Two Sessional, End Term Examination |
| 45 | Eigen values , eigen vectors and their properties | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.4 | Quizzes, assignments, Two Sessional, End Term Examination |
| 46 | Linear combination of vectors, Linear span, some theorems on Linear span | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.5 | Quizzes, assignments, Two Sessional, End Term Examination |
| 47 | Linear dependency and independency of vectors with problems | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.5 | Quizzes, assignments, Two Sessional, End Term Examination |
| 48 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.5 | Quizzes, assignments, Two Sessional, End Term Examination |

| | | | | | |
|---|---|---|---|---|---|
| 49 | Definition of Basis, Spanning set with problems | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.5 | Quizzes, assignments, Two Sessional, End Term Examination |
| 50 | Inner product space | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.5 | Quizzes, assignments, Two Sessional, End Term Examination |
| 51 | Orthogonal basis and orthonormal basis. Gram Schmidt orthogonalization to construct Orthonormal basis | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Lecture, Discussion & Examples | 1101.5 | Quizzes, assignments, Two Sessional, End Term Examination |
| 52 | Tutorial | Identify, formulate, apply appropriate techniques,_professional ethics, Communicate effectively & life-long learning | Problem solving | 1101.5 | Quizzes, assignments, Two Sessional, End Term Examination |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| MA1101.1 | To describe the concept of ODE and their applications to solve the problems | 3 | 3 | 1 | 3 | 1 | | | | 2 | | 2 | 1 |
| MA1101.2 | To describe the concept of Interpolation, Numerical differentiation & integration and their applications and in real life problems. | 3 | 2 | 2 | 2 | 2 | | | | 2 | | 1 | 1 |
| MA1101.3 | To Describe the concept of numerical methods to evaluate the roots of Algebraic & Transcendental equations and solutions of ODE though which one could develop programming skills to develop the skill of solving the complex problems which | 3 | 2 | 2 | 2 | 2 | | | | 3 | | 3 | 1 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | intern become employable in corporate sector | | | | | | | | | | | | |
| MA1101.4 | To Describe the concept of rank for the matrix by solution of the system of linear equations and developed the their skill to solve engineering application based problems. | 3 | 3 | 2 | 3 | 2 | | | | 1 | | 2 | 1 |
| MA1101.5 | To Describe the basic concepts of vector space and to analysis the problems having engineering applications. | 2 | 2 | 1 | 2 | 3 | | | | 2 | | 2 | 1 |

# MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

BASIC MECHANICAL ENGINEERING| ME 1001 | 3 Credits | 3 0 0 3

Session: Jan 20 – Apr 20 | Faculty: Hemant Raj Singh | Class: I Year

**A. Introduction:** Basic Mechanical Engineering is a brief overview of mechanical engineering that makes the students familiar with the basic concepts of Mechanical Engineering. It provides a systematic introduction to the basic elements of mechanical systems while emphasizing the underlying working principles important in understanding the functioning of mechanical systems and processes which involves energy carrier (working fluid i.e. steam), energy and its transformation, steam generator, refrigeration and air-conditioning, power producing and consuming devices, power transmission devices and manufacturing processes.

**B. Course Outcomes:** At the end of the course, students will be able to

**[ME1001.1]** Understand the fundamental concepts to the basic elements of mechanical systems while emphasizing the underlying working principles important in understanding the functioning of mechanical systems and processes.

**[ME1001.2]**. Apply laws of thermodynamics on engineering processes.

**[ME1001.3]** Design and analyse the concepts of components, (I.C. Engine, Steam Generator, Refrigerator, Steam Turbine, Machine Tools, Power Transmitting devices and Manufacturing Processes etc.).

**[ME1001.4]** Analyse the concepts of manufacturing in the context of mechanical applications.

**[ME1001.5]** Apply the concept of thermodynamics and manufacturing processes to design/utilize the power generating, power consuming and manufacturing devices thus increasing the employability in industries.

**C. Program Outcomes and Program Specific Outcomes**

**[PO.1].** **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**[PO.2].** **Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences**.**

**[PO.3].** **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

**[PO.4].** **Conduct investigations** of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions**.**

**[PO.5].** **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an under- standing of the limitations.

**[PO.6].** **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

**[PO.7].** **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

**[PO.8].** **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice**.**

**[PO.9].** **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

**[PO.10]. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions**.**

**[PO.11]. Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to owners own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**[PO.12]. Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**D. Assessment Rubrics:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 20 |
| | Sessional Exam II (Close Book) | 20 |
| | Quizzes(10) and Assignment (10) | 20 |
| End Term Exam (Summative) | End Term Exam (Close Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Quizzes | 3 Quizzes (Close Book) | |

**E. Syllabus**

**Working Fluid**: Properties of steam, Steam tables, Steam Generators, Classification, Construction and working of Simple boiler. **Refrigeration and Air Conditioning:** Definition, concept, Vapour Compression cycle, C.O.P., working principles and schematic diagrams of Refrigerator, Air Conditioner. **Internal Combustion Engine**: Classification, Otto and Diesel cycles, Construction and working of SI and CI engine, Two stroke and Four stroke engine, Calculation of thermal efficiency of cycles. Introduction of **Lubrication**: Need, Methods of lubrication, Splash & Force lubrication. **Steam turbines**: Definition, function, classification and parts of steam turbine, Impulse and reaction turbine - working principle, P – V diagram. **Power Transmission:** Classification and applications of mechanical drives like belts, ropes, chains and gear drives and their velocity ratios, length of belts, power transmitted, ratio of tensions in belts and ropes, gear trains, Calculation of different parameters. **Machine Tools**: Construction, Working and specification of Lathe, Drilling machine, Shaper and Milling machine. **Foundry:** Foundry tools and equipments, Procedure for moulding. **Welding:** Definition, Gas and Arc welding, Soldering and Brazing. **Forging:** Definition, applications, tools Different Forging operations.

**F. Text Book:**

T1. Elements of Mechanical Engineering, Mathur, Mehta and Tiwari, Jain Brother, (Thirteenth Edition), 2016.

**G. Reference Book:**

R1. Thermodynamics: An Engineering Approach, Y.A. Cengel and M.A. Boles, McGraw Hill (Fifth Edition), 2006.

R2. Workshop Technology, Vol. I, W. A. J. Chapman, CBS Publishers & Distributors(Fifth Edition), 2001

**H. Lecture Plan:**

| Lec No | Topics | Session Objective | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introduction, aims and objectives of the course and elementary fundamentals of thermodynamics | Know the basics of the course and understand its applications | Lecture | ME1001.1 | Class Quiz Mid-Term I End-Term |
| 2 | **Properties of steam:** formation of steam experiment | Discuss the terms system and surroundings, thermodynamic properties and describe their use | Lecture | ME1001.1 | |
| 3 | Different states of steam, enthalpy of steam and Measurement of Dryness fraction | Understand the type of steams | Lecture | ME1001.1 | |
| 4 | Numerical on properties of steam | Estimating the properties of steam using steam tables. | Lecture/Activity | ME1001.1 ME1001.2 | |
| 5 | **Steam Boilers** – definition, function and classification | Know the basics of the steam boiler and understand its applications | Lecture | ME1001.1 | |
| 6 | Lancashire boiler – construction, working principle and applications | Understand the concept of Lancashire boiler | Lecture | ME1001.1 | |
| 7 | Boiler mountings & accessories, Comparison between boiler mountings & accessories | Know the basics of the Boiler its accessories and mounting | Lecture | ME1001.1 | |
| 8 | **Refrigeration**: Principle and major parts of an refrigeration system and Air Conditioner | Understand various thermodynamic principles related with refrigeration | Lecture/Activity/Lab Visit | ME1001.1 | Class Quiz Mid-Term I End-Term |
| 9 | Vapour compression refrigeration system: working principle | Know the basics of the Vapour compression refrigeration system | Lecture | ME1001.2 ME1001.3 ME1001.4 | |
| 10 | Classification of refrigerants and properties of an ideal refrigerant Commonly used refrigerants | Know the criteria in selection of refrigerants and their use | Lecture | ME1001.1 | |
| 11 | **I. C. Engines**: classification, parts and I.C Engine terms | Know the basics of the I.C. Engine and understand its applications | Lecture/ Activity/ Lab visit | ME1001.1 ME1001.2 | |
| 12 | working of four stroke petrol engine | Know the basics of the four S SI engine and understand its applications | Lecture | ME1001.1 ME1001.2 | |
| 13 | Working of four stroke diesel engine | Know the basics of the four S CI engine and understand its applications | Lecture | ME1001.1 ME1001.2 | |
| 14 | Two stroke engines and Working of two stroke petrol engine, Working of two stroke diesel engine | Know the basics of the two S Engine and understand its applications | Lecture | ME1001.1 ME1001.2 ME1001.3 | |

| | | | | | |
|---|---|---|---|---|---|
| 15 | comparison between petrol & diesel engines | Analyse the differences | Lecture | ME1001.2<br>ME1001.3 | |
| 16 | Comparison between four stroke & two stroke engines and Important definitions | Analyse the differences | Lecture | ME1001.1<br>ME1001.2<br>ME1001.3 | |
| 17 | Problems on I. C. Engines | Estimating the properties of IC Engine | Lecture/Activity | ME1001.2<br>ME1001.3 | |
| 18 | **Lubrication:** Methods of lubrication, Splash & Force lubrication, | Know the basics of the lubrication and understand its applications | Lecture | ME1001.1 | Class Quiz<br>Mid-Term II<br>End-Term |
| 19 | **Steam turbines** :definition, function, classification and comparison with steam engine | Know the basics of the steam turbine and understand its applications | Lecture | ME1001.1 | |
| 20 | Impulse turbine - working principle and P – V diagram, Reaction turbine - working principle, | Understand the impulse and reaction turbine | Lecture | ME1001.1<br>ME1001.3 | |
| 21 | Reaction Turbine-PV diagram (Continued),Difference between impulse & reaction turbine | Compare and understand the steam turbines | Lecture | ME1001.3 | |
| 22 | **Power Transmission:** Introduction, Significance and definitions, Different methods of power transmission, types of belt drives, | Know the basics of power transmission and understand its applications | Lecture | ME1001.1 | Class Quiz<br>Mid-Term II<br>End-Term |
| 23 | types of pulleys and its application, V – belt introduction and advantages | Know the type of belt and its use | Lecture | ME1001.1 | |
| 24 | Derivation of length of belt (open and cross) | Estimate the length of belt drives | Lecture/Activity | ME1001.1 | |
| 25 | Calculation of Velocity ratio for belt drive, introduction of slip and creep | Estimating the velocity ratio of belt drive | Lecture/Activity | ME1001.3<br>ME1001.5 | |
| 26 | Calculation of Tension in belt drive (open), Power transmitted in belt drive and Numerical on belt drives | Estimating the tension in belt | Lecture/Activity | ME1001.3<br>ME1001.5 | |
| 27 | Gear drives, types of gears and their application | Know the basics of the gear drives and understand its applications | Lecture | ME1001.1<br>ME1001.3<br>ME1001.5 | |
| 28 | Calculation of velocity ratio for gear drive, gear train (simple and compound) | Estimating the velocity ratio of gear drive | Lecture | ME1001.3<br>ME1001.5 | |
| 29 | **Machine tools**: Introduction **Lathe**- Basic introduction , explanation of principal parts of lathe with the help of diagram and working principle | Know the basics of the machine tool and understand its applications | Lecture | ME1001.1<br>ME1001.3<br>ME1001.5 | Class Quiz<br>End-Term |
| 30 | Specification of lathe Machine, Types of operations- Turning, Facing, Knurling, Parting, Grooving, Chamfering, taper turning | Analyse the Lathe Machine and its operation | Lecture | ME1001.1<br>ME1001.2<br>ME1001.3<br>ME1001.5 | |
| 31 | **Drilling**: Introduction, classification of drilling machines, operations | Know the basics of the Drilling and understand its applications | Lecture | ME1001.1<br>ME1001.3 | |
| 32 | Introduction to Shaper and Milling machine | Know the basics of the Milling and shaper | Lecture/ Workshop Visit | ME1001.1<br>ME1001.3 | |

| | | | | | |
|---|---|---|---|---|---|
| | | and understand its applications | | | |
| 33 | **Foundry:** Usage of Foundry tools and equipments, | Know the basics of the Foundry and understand its applications | Lecture | ME1001.1<br>ME1001.3<br>ME1001.5 | Class Quiz<br>End-Term |
| 34 | Procedure of moulding process | Know the Procedure for moulding. | Lecture | ME1001.1<br>ME1001.2<br>ME1001.3<br>ME1001.5 | |
| 35 | **Welding:** Definition, Classification majorly Gas and Arc welding, | Know the basics of the welding and understand its applications | Lecture | ME1001.1<br>ME1001.2<br>ME1001.3 | |
| 36 | Principle of Oxy-Acetylene gas welding, flames and its application | Understand the gas welding | Lecture | ME1001.1<br>ME1001.2<br>ME1001.3<br>ME1001.5 | |
| 37 | Principle of electric arc welding, Soldering and Brazing. | Understand the arc welding | Lecture | ME1001.1<br>ME1001.2<br>ME1001.3 | |
| 38 | **Forging:** Definition, applications, tools Different Forging operations | Know the basics of the forging and understand its applications | Lecture/ workshop visit | ME1001.1<br>ME1001.2<br>ME1001.3<br>ME1001.5 | |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| **ME1001.1** | Understand the fundamental concept to the basic elements of mechanical systems while emphasizing the underlying working principles important in understanding the functioning of mechanical systems and processes. | 3 | | | | | | | | | | | |
| **ME1001.2** | Apply laws of thermodynamics on engineering processes. | 3 | 2 | | | | | | | | | | |
| **ME1001.3** | Design and analyse the concept of components, (I.C. engine, Steam generator, Refrigerator, turbine, Machine tools, power transmitting devices and Manufacturing processes etc.). | 3 | | 3 | 2 | | | | | | | | |
| **ME1001.4** | Analyse the concept of second law and entropy in the context of thermal applications. | 3 | 2 | 3 | 2 | | 2 | 2 | | | | | |
| **ME1001.5** | Apply the concept of thermodynamics and manufacturing processes to design/utilize the power generating, power consuming and manufacturing devices. | 3 | 3 | 3 | | | 2 | 2 | | | | | |

# MANIPAL UNIVERSITY JAIPUR

School of Automobile, Mechanical and Mechatronics

**DEPARTMENT OF MECHANICAL ENGINEERING**

Course Hand-out

Engineering Graphics| ME 1002 | 3 Credits | 0 0 6 3

Session: Jan 20 – Apr 20 | Course Coordinator: Dr. Mithilesh Kumar Dikshit | Class: I Year B.Tech

**A. Introduction:** This course teaches the basics of engineering drawing utilising free hand sketching, mechanical drawing, and computer aided drafting. The fundamental principles of orthographic projection as well as the topics of dimensioning, sectional views, isometric and perspective pictorials views, descriptive geometry and assembly drawings are taught.

**B. Course Outcomes:** Upon successful completion of this course:

**[ME1002.1].** Students will be able to understand the conventions and the methods of engineering drawing.

**[ME1002.2].** Students will be able to understand the theory of projections. Draw orthographic projection of lines, planes and solids.

**[ME1002.3].** Students will learn to apply sectional views to most practically represent engineered parts**.** Students will have skill to prepare basic engineering models.

**[ME1002.4].** Student will learn design and drafting in autocad. Understand the application of industry standards and techniques applied in engineering graphics.

**C. Program Outcomes and Program Specific Outcomes**

**[PO.1] Engineering Knowledge**: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**[PO.2] Problem Analysis**: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

**[PO.3] Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

**[PO.4] Conduct investigations** of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

**[PO.5] Modern Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an under-standing of the limitations.

**[PO.6] The Engineer and Society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

**[PO.7] Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

**[PO.8] Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

**[PO.9] Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

**[PO.10] Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

**[PO.11] Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply these to owners own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**[PO.12] Life-long Learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Performance on sheets (Manual Drawing) | 30 |
| | Performance on AUTOCAD | 20 |
| | Viva voce | 10 |
| End Term Exam (Summative) | End Term Exam | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester Examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to his/her faculty about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |

## E. Syllabus

Principle of Orthographic Projections: Points, straight lines parallel to one ref. plane (HP/VP) and inclined to other ref. plane; Straight lines inclined to both HP and VP; Straight lines inclined to both HP & VP and parallel to PP; Straight lines with traces; Practical problems on straight lines. Projections of Plane surfaces: Perpendicular one ref. plane ( HP/VP ) and inclined to other ref. plane, Inclined to both HP & VP, Inclined to both HP & VP and perpendicular to PP. Projections of Solids (right regular) by change of position method: Axis parallel to one ref. plane (HP/VP) and inclined to other ref. plane, Resting on one of the ref. plane, axis inclined to both HP & VP, Suspended freely, axis inclined to both HP & VP, Axis inclined to both HP & VP parallel to PP. Projections of solids by Auxiliary plane method: Axis inclined to both HP and VP. Sections of solids (right regular and no spheres): Using Horizontal and vertical section planes using section plane perpendicular to one ref. plane and inclined to the other ref. plane, Given the regular true shapes of various solids and find the inclination of section plane. Development of surfaces: Parallel line development, Radial line development, Triangulation development. Isometric projections: Plane surfaces and simple solids (prisms & cylinders), Frustum and combination of solids, Simple machine elements. Introduction to Computer Aided Drafting.

## F. Text Books:


1. Bhat N. D., Engineering Drawing Charotar Publishing House, Anand , 2000.
2. Jeyapoovan T. Engineering Drawing and graphics Using AutoCAD, 3rd Ed. Vikas Publishing House Pvt. Ltd.,2010.


## G. Reference Books:


1. Gopalkrishna K. R., Engineering Graphics, Suhas Publications, Bangalore, 2001.
2. Venugopal K., Engineering Drawing and Graphics + Autocad Newage International Publishers, Delhi (2001).
3. Narayana K. L. and Kannaiah P., Text book on Engineering Drawing, Scitech Publications, Chennai (2002).


## H. List of Sheets

1. Projection of Points
2. Projection of Lines (inclined to one plane and parallel to other)
3. Projection of Lines inclined to both the planes and Traces of a line
4. Projection of Planes
5. Projection of Solids
6. Projection of Sections of Solids & Development of Surfaces
7. Isometric projections

### CAD

1. Introduction to Auto-CAD and commands
2. Questions on projection of lines
3. Questions on projection of lines inclined to both the planes
4. Questions on projection of planes
5. Basic concept of 3D drafting and drawing

**I. Lecture Plan:**

| Lecture Number | Topics | Session Outcomes | Mode of delivery | **Corresponding CO** | Assessments |
|---|---|---|---|---|---|
| 1 | Introduction to Engineering Graphics | Layout of drawing sheet, conventions, scales, Dimensioning, Letterings and Numberings | Board/PPT | ME1002.1 | Sheet performance in class/End terms |
| 2 | Theory of projection. Projection of Points | Types of Projections, orthographic projections, plane of projection, Quadrants, Angles of projections | Board/PPT | ME1002.1 | |
| 3 | Problems on projection of points | Position of point, to find distance between any two points | Board/PPT | ME1002.1 | |
| 4 | Projection of lines inclined to one plane and perpendicular to another plane | Position and projection of straight line, Methods for determining true length and true inclinations. | Board/PPT | ME1002.2 | Sheet performance in class/End terms |
| 5 | Problems practice of lines inclined to one plane and parallel to other plane | Classroom practice. | Board/PPT | ME1002.2 | |
| 6 | Projection and traces of straight line inclined to both planes | Projection of straight line inclined to both planes, determining apparent top view and apparent front view, angle of inclinations with both the planes. | Board/PPT | ME1002.2 | |
| 7 | Problems practice on Lines inclined to both planes and traces of a line | Projection of straight line and traces. | Board/PPT | ME1002.2 | |
| 8 | Projection of planes | Introduction to plane, location of plane, types of planes, Projection concepts | Board/PPT | ME1002.2 | Sheet performance in class/End terms |
| 9 | Problems practice on projection of planes inclined to one plane and planes inclined to both planes | Projection of planes, perpendicular planes, plane inclined to reference planes | Board/PPT | ME1002.2 | |
| 10 | Projection of Solids (right regular and by change of position method) | Introduction, types of solids, position of | Board/PPT | ME1002.2 | Sheet performance |

| | | | | | |
|---|---|---|---|---|---|
| | | solids w.r.t. HP and VP | | | in class/End terms |
| 11 | Problems practice on projection of solids | Projection of solids in simple positions, Position of solids in typical positions | Board/PPT | ME1002.2 | |
| 12 | Problems on projection of solids inclined to both planes | Oblique solids, Frustum of cone and Pyramid, Truncated solids | Board/PPT | ME1002.2 | |
| 13 | Problems on projection of solids | suspended freely and axis inclined to both planes, Axis inclined to both HP & VP, parallel to PP | Board/PPT | ME1002.2 | |
| 14 | Problems on projection of solids | Projection of solids by auxiliary plane method; Axis inclined to both HP & VP | Board/PPT | ME1002.2 | |
| 15 | Projection of sections of solids | Introduction, section of solids, Different terminology, classifications | Board/PPT | ME1002.3 | Sheet performance in class/End terms |
| 16 | Projection of sections of solids | Section perpendicular to VP and parallel to HP, Section perpendicular to HP and parallel to VP | Board/PPT | ME1002.3 | |
| 17 | Problems on projection of sections of solids | Section perpendicular to VP and inclined to HP, Section perpendicular to HP and inclined to VP | Board/PPT | ME1002.3 | |
| 18 | Development of surfaces | Parallel line development, Radial line development and Triangular development | Board/PPT | ME1002.3 | Sheet performance in class/End terms |
| 19 | Development of Surfaces | Problems on Development of Surfaces for prism, pyramid, cone cylinder | Board/PPT | ME1002.3 | |
| 20 | Isometric view and projection | Introduction, Difference between isometric view and isometric projection, Isometric axis, | Board/PPT | ME1002.3 | Sheet performance in class/End terms |

| | | | | | |
|---|---|---|---|---|---|
| | | isometric lines and isometric planes | | | |
| 21 | Problems on Isometric view and projection of planes and solids | Dimensioning on isometric projection Isometric view and projection of plane geometries, Four center method to draw isometric view and projection of circle, Isometric view of right solids | Board/PPT | ME1002.3 | |
| 22 | Problems on Isometric projection of planes and solids | Isometric view and projection of Truncated solids, frustum | Board/PPT | ME1002.3 | |
| 23 | Introduction to Auto CAD | Introduction, CAD applications, AUTOCAD workspace, Setting up drawing space, sheet layout, command execution | PPT | ME1002.4 | Classroom Test |
| 24 | Commands and Projection of lines and lines inclined to both planes using Auto CAD | Methods of locating a point, Drawing lines and curves, texting and dimensioning of drawings | AUTOAD | ME1002.4 | |
| 25 | Commands and Projection of planes using AUTOCAD | Drawing of polygons using commands, editing commands like OFFSET, FILLET, CHAMFER, TRIM, EXTEND, BREAK, ROTATE, MIRROR etc. | AUTOCAD | ME1002.4 | |
| 26 | 3D objects | Commands: EXTRUDE, CYLINDER, CONE, BOX, UNION, SUBSTRACT and SECTION | AUTOCAD | ME1002.4 | |

## J. Course Articulation Matrix: (Mapping of COs with POs)

| CO | STATEMENT | Correlation With Program Outcomes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ME1002.1** | Students will be able to understand the conventions and the methods of engineering drawing. | 3 | 1 | 2 | 1 | | | | | | | | 2 |
| **ME1002.2** | Students will be able to understand the theory of projections. Draw orthographic projections of lines, planes and solids. | 3 | 2 | 2 | 1 | | | | | | | | 2 |
| **ME1002.3** | Students will learn to apply sectional views to most practically represent engineered parts**.** Students will have **skill** to prepare basic engineering models. | 3 | 3 | 3 | 1 | | | | | | | | 2 |
| **ME1002.4** | Student will learn **design and drafting** in autocad. Understand the application of industry standards and techniques applied in engineering graphics. | 3 | 3 | 3 | 2 | 3 | | | | | | | 2 |

**1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

Basic Workshop Practice| ME 1030 | 1 Credits

Session: JAN 20 – APR 20 | Faculty: Ashish Sharma

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering which focuses on mainly hands on learning based on various working shops like lathe machine, welding, engines, UTM, residential wiring design, power supply and building plan. This course gives an overview of fundamental working of various machine tools, compressive strength of building materials and electrical- electronics instruments.

**B. Course Outcomes:** At the end of the course, students will be able to

**ME1030.1** Understand about the various measuring, marking and cutting tools and Comprehend the safety measures required to be taken while using tools.

**ME1030.2** Acquire skills and Knowledge about lathe machine, welding machines and 2S-4S engines and their operations.

**ME1030.3** Learn different techniques for quality assurance check of building materials.

**ME1030.4** Analyse the profile of existing ground for any infrastructure development project

**ME1030.5** Understand about the basic construction and working principle of fluorescent lamp, ceiling fan and three Phase Induction machine

**ME1030.6** Analyse the characteristics of different electronic components and CRO.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**[PO.1]. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2]. Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3]. Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

**[PO.4]. Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

**[PO.5]. Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6]. The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

**[PO.7]. Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8]. Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9]. Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10]. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Job preparation- | 30 |
| | File/Records- | 15 |
| | Viva- | 15 |
| End Term Exam (Summative) | End Term Exam (External Practical Exam) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup class on the job done on the day of absence will be given which has to be completed within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These jobs are limited to a maximum of 2 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

1. Study of parts of lathe machine and lathe operations
2. Perform different operations on lathe machine like Facing, Turning, Taper Turning and knurling on MS cylindrical work piece
3. Study of types of welding process and perform welding of different types of joint on MS plate with arc welding process
4. Study of two stroke and four stroke engines.
5. Layout of a small building plan on ground.
6. Levelling around Academic block.
7. Measurement of tensile strength of reinforcement bar using UTM.
8. Measurement of compressive strength of Brick/Cement by CTM.
9. Designing of residential wiring and study of three phase induction motor.
10. Study of the working of fluorescent lamp and ceiling fan.
11. Use of electronic Instruments and tools.
12. Building DC Regulated Power Supply.

## F. TEXT BOOKS


i. Hajra Choudhury S. K and Bose S. K, Elements of Workshop Technology, Vol I, Media
ii. Promoters & Publishing Pvt. Ltd., Mumbai, 2012.

iii. Raghuvanshi S.S, Workshop Technology, Dhanpat Rai and Sons, Delhi, 2002.
iv. Punmia B. C, Surveying, Laxmi Publications, Bangalore, 2012.
v. Uppal S.L., Electrical Wiring, Estimating and Costing, Khanna Publishers, 1978.
vi. Bishop Owen, Electronics: A First Course, (2e), NEWNES, An Imprint of Elsevier, 2006.

**Lecture Plan:**

| Lec No | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | Study of parts of lathe machine and lathe operations | Understanding building of tools and lathe machines | Lecture+Lab | 1030.1 | Lab Experiment |
| 2 | Perform different operations on lathe machine like Facing, Turning, Taper Turning and knurling on MS cylindrical work piece | Performance of different operations | Lecture+Lab | 1030.1 | Lab Experiment |
| 3 | Study of types of welding process and perform welding of different types of joint on MS plate with arc welding process | Understanding of welding processes | Lecture+Lab | 1030.2 | Lab Experiment |
| 4 | Study of two stroke and four stroke engines. | Knowledge of IC engines | Lecture+Lab | 1030.2 | Lab Experiment |
| 5 | Layout of a small building plan on ground. | Understanding of building layout | Lecture+Lab | 1030.3 | Lab Experiment |
| 6 | Levelling around Academic block. | Have information regarding levelling | Lecture+Lab | 1030.3 | Lab Experiment |
| 7 | Measurement of tensile strength of reinforcement bar using UTM. | UTM experiment | Lecture+Lab | 1030.4 | Lab Experiment |
| 8 | Measurement of compressive strength of Brick/Cement by CTM. | CTM experiment | Lecture+Lab | 1030.4 | Lab Experiment |
| 9 | Designing of residential wiring and study of three phase induction motor. | Gain knowledge about residential wiring | Lecture+Lab | 1030.5 | Lab Experiment |
| 10 | Study of the working of fluorescent lamp and ceiling fan. | Study of lamp and ceiling fan | Lecture+Lab | 1030.5 | Lab Experiment |

| | | | | | |
|---|---|---|---|---|---|
| 11 | Use of electronic Instruments and tools. | Analyze the characteristics of different electronic components and its applications. | Lecture+Lab | 1030.6 | Lab Experiment |
| 12 | Building DC Regulated Power Supply. | Understanding of small circuits. | Lecture+Lab | 1030.6 | Lab Experiment |

**G. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
| ME1030.1 | Understanding about the various measuring, marking and cutting tools and Comprehend the safety measures required to be taken while using tools. | 1 | | | | 1 | | 1 | | 1 | | | 1 |
| ME1030.2 | Acquire skills and Knowledge about lathe machine, welding machines and 2S-4S engines and their operations. | | 1 | | | | | | | 1 | | | |
| ME1030.3 | Learn different techniques for quality assurance check of building materials. | 1 | 1 | | | 1 | | | | | | | 1 |
| ME1030.4 | Analyse the profile of existing ground for any infrastructure development project | 1 | | | | 1 | | | | 1 | | | 1 |
| ME1030.5 | Understand about the basic construction and working principle of fluorescent lamp, ceiling fan and three Phase Induction machine | 1 | | | | 1 | | | | 1 | | 1 | 1 |
| ME1030.6 | Analyze the characteristics of different electronic components and CRO. | 1 | 1 | | | | | 1 | | 1 | | | 1 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

**MANIPAL UNIVERSITY JAIPUR**

School of Basic Sciences

Department of Physics

Course Hand-out

Engineering Physics | PY1001 | 4 Credits | 3 1 0 4

Session: Jan- Apr, 2020| Faculty: Dr. Saikat | Class: B.Tech. I Sem.

**A. Introduction:** The mission of the Engineering Physics course is to prepare students for careers in engineering where physics principles can be applied to the advancement of technology. The course work will develop sufficient depth in physics skills to produce engineers who can relate fundamental physics to practical engineering problems, and will possess the versatility to address new problems in our rapidly changing technological base. The present course is meant to provide a more thorough grounding in applied physics for a selected specialty such as optics, quantum physics, atomic & molecular physics and solid-state physics. The discipline is also meant for cross-functionality and bridges the gap between theoretical science and practical engineering. It is notable the term ‘‘engineering physics" is also called as "technical physics" in several universities and colleges.

**B. Course Objectives:** At the end of the course, students will be able to

**[1001.1]** identify clearly the wide range of diversity in science and technology with the help of knowledge of the basic Physics.
**[1001.2]** justify and explain various processes involved in understanding the nature of light.
**[1001.3]** categorize and investigate the problems and applications of quantum physics.
**[1001.4]** understand and relate the fundamentals of quantum mechanics and apply the skills to solve one dimensional motion of particles.
**[1001.5]** impart the knowledge of empirical laws based on Solid State Physics and Atomic and Molecular Physics.
**[1001.6]** develop skills in imparting practical knowledge to real time solution of industrial problems

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**[PO.1] Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
**[PO.2] Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
**[PO.3] Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
**[PO.4] Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
**[PO.5] Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
**[PO.6] The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
**[PO.7] Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
**[PO.8] Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9] Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10] Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11] Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12] Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignment (Accumulated and Averaged) | 20 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

**Optics:** Two source interference, double slit interference, coherence, intensity in double slit interference, thin film interference, air-wedge, Newton`s rings, Michelson`s interferometer, diffraction and wave theory of light, single-slit diffraction, intensity in single-slit diffraction (using phasor method), diffraction at a circular aperture, double-slit interference and diffraction, combined-intensity in double-slit diffraction (qualitative approach), diffraction of light through multiples slits, diffraction gratings, dispersion and resolving power of gratings, polarization of electromagnetic waves, polarizing sheets, polarization by reflection, double refraction; **Quantum Physics:** Black body radiation and Planck`s hypothesis, Stefan`s Law, Wein`s displacement law, Photoelectric effect, Compton effect, photons and electromagnetic waves, wave properties of particles, de Broglie hypothesis, Davisson-Germer experiment, quantum particle (wave packet, phase velocity, group velocity), the uncertainty principle; **Quantum Mechanics:** An interpretation of quantum mechanics, wave function and its significance, Schrödinger equation, particle in a box, particle in a well of finite height (qualitative), Tunneling through a potential barrier and its applications, the simple harmonic oscillator (qualitative); **Atomic Physics & Molecular Physics:** Atomic spectra of gases, energy states and spectra of molecules (rotational and vibrational energy levels), X-rays spectrum, Moseley's law, spontaneous and stimulated transitions, He-Ne and Ruby laser, application of lasers; **Solid State Physics:** band theory of solids, electrical conduction in metals, insulators and semiconductors, Superconductivity, type-I and type-II superconductors, Meisner effect, BCS theory (Introductory) and applications of superconductivity.

## F. TEXT BOOKS


1. Halliday, Resnick, Krane, PHYSICS, Volume 2, 5th edition, John Wiley & Sons, Inc, 2011
2. Beiser & Mahajan, Modern Physics, Mc Graw Hill, 6th edition., 2009

## G. REFERENCE BOOK

Serway & Jewett, PHYSICS for Scientists and Engineers with Modern Physics; Volume 2,6th edition, 2013

## H. Lecture Plan:

| Lec. No. | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | Discussion of Lecture Plan | To acquaint and clear teachers expectations and understand student expectations | Lecture | **1001.1** | NA |
| 2 | Introduction to OPTICS | To make the student understand the difference between physical and geometrical optics. Recall elementary idea of transverse and longitudinal waves. Develop mathematical representation of waves. | Flipped Classroom | **1001.1 & 1001.2** | In Class Quiz (Not Accounted) |
| 3 | Interference of light, Young's double slit interference, coherence | Understanding of the concept of coherent waves and interference | Lecture | **1001.2** | Class Quiz – 1<br>Home Assignment - 1<br>Mid Term 1<br>End Term |
| 4 | Intensity in double slit interference using Phasor method | Derivation of the formula for intensity distribution in double slit interference | Lecture | **1001.2** | Class Quiz – 1<br>Home Assignment - 1<br>Mid Term 1<br>End Term |
| 5 | Interference in thin film, antireflection coatings | Understand the concept of thin-film interference | Lecture | **1001.2 & 1001.6** | Class Quiz – 1<br>Home Assignment - 1<br>Mid Term 1<br>End Term |
| 6 | TUTORIAL:1 | | Activity (Think Pair Share) | | |
| 7 | Interference in wedge shaped air film | Understand the concept of interference in wedge shaped films and introduction to Newton's ring | Lecture | **1001.2 & 1001.6** | Class Quiz – 1<br>Home Assignment - 1<br>Mid Term 1<br>End Term |
| 8 | Newton's rings – theory and experiment | Describe the Newton's ring experiment and develop the theory of Newton's ring | Lecture | **1001.2** | Class Quiz – 1<br>Home Assignment- 1<br>Mid Term 1<br>End Term |
| 9 | **TUTORIAL: 2** | | Activity (Think Pair Share) | | |
| 10-11 | Michelson interferometer – construction & | Description of Michelson interferometer and derivation of the formula | Lecture | **1001.2** | Class Quiz – 1<br>Home Assignment - 1 |

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|---|---|---|---|---|---|
| | theory ( Qualitative approach only), Applications of Michelson interferometer ( determination of wavelength) | for determination of wavelength using it. | | | Mid Term I<br>End Term |
| 12 | **TUTORIAL: 3** | | Activity (Think Pair Share) | | |
| 13-14 | Diffraction and wave theory of light, Fraunhoffer diffraction at single slit – theory and intensity distribution | Introduction to diffraction and understand the difference between Fraunhoffer and Fresnel diffraction | Lecture, Activity | **1001.2** | Class Quiz – 2<br>Home Assignment-2<br>Mid Term I<br>End Term |
| 15-16 | Analysis by Phasor method, Intensity distribution curve, Diffraction at a circular aperture | Develop the theory and formula for single slit diffraction | Lecture | **1001.2** | Class Quiz – 2<br>Home Assignment - 2<br>Mid Term I<br>End Term |
| 17 | **TUTORIAL:4** | | Activity (Think Pair Share) | **1001.2** | |
| 18 | Fraunhoffer diffraction at double slit – theory ( Qualitative approach only) and intensity distribution | Qualitatively develop the formula for intensity distribution in double slit diffraction | Lecture | **1001.2** | Class Quiz – 2<br>Home Assignment - 2<br>Mid Term I<br>End Term |
| 19 | Fraunhoffer diffraction at multiple slit – theory and intensity distribution, Diffraction grating | Understand the multiple slit diffraction pattern and diffraction grating | Lecture | **1001.2** | Class Quiz – 3<br>Home Assignment-2<br>Mid Term I<br>End Term |
| 20 | **TUTORIAL:6** | | Activity (Think Pair Share) | **1001.2** | |
| 21 | Rayleigh's criteria of resolution, Dispersion and resolving power of grating | Understand the Raleigh's criteria for resolution and derive the expression for dispersive and resolving power | Lecture | **1001.2** | Class Quiz – 3<br>Home Assignment-2<br>Mid Term I<br>End Term |
| 22 | **TUTORIAL:7** | | Activity (Think Pair Share) | **1001.2** | |
| 23-24 | Polarization of EM Waves, Polarizing sheets, | Understand the phenomena of polarisation | Lecture | **1001.2** | Class Quiz – 3<br>Home Assignment - 3 |

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|---|---|---|---|---|---|
| | Polarization by reflection, Double refraction, Malus law & Brewsters law | and different approaches to polarise EM waves | | | Mid Term I<br>End Term |
| 25 | **TUTORIALS: 8** | | Activity (Think Pair Share) | **1001.2** | |
| 26-27 | Black body radiation , Wein's law, Stefan-Boltzmann law, Raleigh-Jeans Law, UV Catastrophe, Planck's hypothesis and Planck's law of black body radiation | Understand the laws of Black Body radiation and introduction to Planck's hypothesis | Flipped Class, Lecture | **1001.1 & 1001.3** | Class Quiz – 4<br>Home Assignment - 4<br>Mid Term II<br>End Term |
| 28-29 | Photoelectric effect, Experimental observations of Photoelectric effect, Compton effect ( Qualitative approach) | Describe the theory of Photoelectric effect and Compton effect | Lecture | **1001.1 & 1001.3** | Class Quiz – 4<br>Home Assignment - 4<br>Mid Term II<br>End Term |
| 30 | **TUTORIAL:9** | | Activity (Think Pair Share) | **1001.3** | |
| 31 | Photons and electromagnetic waves, de-Broglie hypothesis of matter wave, Davisson-Germer Experiment | Understand the concept of de-Broglie hypothesis and describe the Davission-Germer Experiment | Lecture | **1001.1 & 1001.3** | Class Quiz – 5<br>Home Assignment - 4<br>Mid Term II<br>End Term |
| 32-33 | Quantum particle, Concept of wave packet. Group and phase velocity, Relation between $V_g$ & $V_p$ in dispersive medium, Uncertainty Principle ( Statement and expression only) and its Physical significance | Understand the Group Velocity and Phase Velocity and the concept of Uncertainty Principle | Flipped Classroom, Lecture | **1001.3** | Class Quiz – 5<br>Home Assignment - 5<br>Mid Term II<br>End Term |
| 34 | **TUTORIAL: 10** | | Activity (Think | **1001.3** | |

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|---|---|---|---|---|---|
| | | | Pair Share) | | |
| 35 | An Interpretation of Quantum mechanics, Wave function and its physical significance, SchrŐdinger wave equation | Introduction to wave function and Schrodinger wave equation | Lecture | **1001.3** | Class Quiz – 5<br>Home Assignment - 5<br>Mid Term II<br>End Term |
| 36 | Particle in a box of infinite potential height | Derive the wave-function and energy of a particle confined in a one dimensional box | Lecture | **1001.3** | Class Quiz – 6<br>Home Assignment - 5<br>Mid Term II<br>End Term |
| 37 | **TUTORIAL: 11** | | Activity (Think Pair Share) | **1001.3** | |
| 38-39 | Particle in a well of finite height ( qualitative), Tunnelling through a potential barrier ( qualitative) and its applications | Qualitatively describe the phenomena of particle in a finite well and the phenomena of tunnelling | Lecture | **1001.3** | Class Quiz – 6<br>Home Assignment - 5<br>Mid Term II<br>End Term |
| 40 | Quantum mechanical simple harmonic oscillator ( Qualitative) | Qualitative discussion of the wave function and energy of a harmonic oscillator | Lecture | **1001.1 & 1003.4** | Class Quiz – 6<br>Home Assignment - 5<br>Mid Term II<br>End Term |
| 41 | **TUTORIAL: 12** | | Activity (Think Pair Share) | | |
| 42-43 | Bohr's Theory, Atomic Spectra of gases, Continuous and characteristic X-rays, Duane – Hunt relation, Moseley's law | Recall Bohr's theory and atomic spectra. Understand the continuous and characteristic X-rays and derive the related formula. | Flipped Classroom, Lecture | **1001.1 & 1001.4** | Class Quiz (Not Accounted)<br>Home Assignment - 6<br>End Term |
| 44-45 | Energy states and spectra of molecules ( Rotational and Vibrational spectra) | Qualitative discussion of Rotational and Vibrational spectra and the related formulas | Lecture | **1001.4** | Class Quiz – 7<br>Home Assignment - 6<br>End Term |
| 46 | **TUTORIAL: 13** | | Activity (Think Pair Share) | | |
| 47 | Lasers- Spontaneous and stimulated transitions, | Understand the lasers and the related optical phenomena. | Lecture | **1001.4 & 1001.5** | Class Quiz – 7<br>End Term |

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| | Population inversion and metastable state, | | | | |
| 48-49 | Construction and working of Ruby laser , Construction and working of He-Ne laser, Energy level diagram of He-Ne laser, Application of Laser | Description of Ruby laser and He-Ne laser and understand their working | Flipped Classroom, Lecture | **1001.5** | Class Quiz – 7<br>End Term |
| 50 | **TUTORIAL: 14** | | Activity (Think Pair Share) | | |
| 51 | Band Theory of solids, Electrical conduction in Metals, Insulators, and Semiconductors | Understand qualitatively the band theory of solids | Lecture | **1001.5 & 1001.6** | Class Quiz – 8<br>End Term |
| 52-53 | Superconductivity: Type- I and Type-II Superconductivity, Meisner effect | Introduction to super conductivity and superconductors and the related phenomena | Lecture | **1001.5 & 1001.6** | Class Quiz – 8<br>End Term |
| 54 | **TUTORIAL: 15** | | Activity (Think Pair Share) | | |
| 55 | BCS Theory ( Introductory) and Applications of superconductivity | Qualitatively understand the BCS theory and their applications | Lecture | **1001.5 & 1001.6** | Class Quiz – 8<br>End Term |
| 56 | **TUTORIAL: 16** | | Activity (Think Pair Share) | | |
| | | | | | |

## I. Course Articulation Matrix: (Mapping of COs with POs and PSOs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | | | | |
| PY 1001.1 | understand the wide range of diversity in science and technology with the help of knowledge of the basic Physics. | 3 | 2 | | | 1 | 2 | 1 | 2 | | 2 | | 1 | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PY 1001.2 | explain various processes involved in understanding the nature of light. | 3 | 3 | 3 | 2 | 2 | 2 | | 1 | 1 | 2 | | 2 | | | | |
| PY 1001.3 | identify the problems and applications of Quantum Physics. | 1 | | 3 | | 1 | | | 1 | 2 | | | 2 | | | | |
| PY 1001.4 | fundamentals of quantum mechanics and apply to one dimensional motion of particles | 2 | 3 | 3 | | | | 1 | | 2 | 1 | | 2 | | | | |
| PY 1001.5 | impart the knowledge of empirical laws based on Solid state Physics and Atomic and Molecular Physics. | | | | 1 | | 1 | 2 | | 1 | | 2 | 2 | | | | |
| PY 1001.6 | develop skills in imparting practical knowledge to real time solution of industrial problems | 2 | 1 | | 2 | 1 | | 2 | 1 | | 2 | 1 | | | | | |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

**MANIPAL UNIVERSITY JAIPUR**

School of Basic Sciences

Department of Physics

Course Hand-out

Engineering Physics Lab | PY1030 | 1 Credit | 0 0 2 1

Session: Jan- Apr, 2020| Faculty: Dr. Saikat | Class: B. Tech. II Sem.

**A. Introduction:** The mission of the Engineering Physics course is to prepare students for careers in engineering where physics principles can be applied to the advancement of technology. The course work will develop sufficient depth in physics skills to produce engineers who can relate fundamental physics to practical engineering problems, and will possess the versatility to address new problems in our rapidly changing technological base. The present course is meant to provide a more thorough grounding in applied physics for a selected specialty such as optics, quantum physics, atomic & molecular physics and solid-state physics. The discipline is also meant for cross-functionality and bridges the gap between theoretical science and practical engineering. It is notable the term "engineering physics" is also called as "technical physics" in several universities and colleges.

**B. Course Objectives:** At the end of the course, students will be able to

**[1030.1]** clearly explain the different type of errors like backlash error, parallax etc.
**[1030.2]** assess the behaviour of basic instruments like Vernier Callipers, screw gauge, spherometer and spectrometer etc and it will enhance their skills to use them.
**[1030.3]** acquire, analyse and process experimental data.
**[1030.4]** compare and contrast the facts and ideas in handling the practical applications of light, electricity sound and modern physics.
**[1030.5]** acquire hands on skills on diverse experimental tools related to physics that are essential for engineering students

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**[PO.1] Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
**[PO.2] Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
**[PO.3] Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
**[PO.4] Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
**[PO.5] Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
**[PO.6] The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
**[PO.7] Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
**[PO.8] Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices
**[PO.9] Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10] Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11] Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12] Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Continuous Assessment/Viva | 60 |
| | | |
| | | |
| End Term Exam (Summative) | End Term Exam | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

Experiments on interference, diffraction and dispersion, experiments on quantum theory of radiation, Experiments on band theory of solids, semiconductors, Experiments on resonance circuits, Hall-effect.

## F. TEXT BOOKS

1. Jewett & Serway, PHYSICS for Scientists and Engineers with Modern Physics (7e), Cengage Learning, 2008.

2. Worsnop & Flint, Advanced Practical Physics for Students (9e), Methuen & Co. Ltd, London 1987.

## G. Lecture Plan:

| Lec No | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Discussion of Lecture Plan | To acquaint and clear teachers expectations and understand student expectations | Lecture | **1030.1** | NA |
| 2 | Experiments on interference | To make the student understand the difference between physical and geometrical optics. Recall elementary idea of transverse and longitudinal waves. Develop mathematical representation of waves. | Hands-on training | **1030.1 & 1030.2** | Continuous Assessment/Viva |
| 3 | Experiments on diffraction and dispersion | Understanding of the concept of coherent waves and interference | Hands-on training | **1030.2 & 1030.3** | Continuous Assessment/Viva |

| | | | | | |
|---|---|---|---|---|---|
| 4 | experiments on quantum theory of radiation | Derivation of the formula for intensity distribution in double slit interference | Hands-on training | **1030.2 & 1030.3** | Continuous Assessment/Viva |
| 5 | Experiments on band theory of solids | Understand the concept of thin-film interference | Hands-on training | **1030.3 & 1030.4** | Continuous Assessment/Viva |
| 6 | Experiments on semiconductors | | Hands-on training | **1030.3, 1030.4 & 1030.5** | Continuous Assessment/Viva |
| 7 | Experiments on resonance circuits | Understand the concept of interference in wedge shaped films and introduction to Newton's ring | Hands-on training | **1030.3, 1030.4 & 1030.5** | Continuous Assessment/Viva |
| 8 | Experiments on Hall-effect | | Hands-on training | **1030.3 & 1030.4** | Continuous Assessment/Viva |
| | | | | | |

## H. Course Articulation Matrix: (Mapping of COs with POs and PSOs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | | | | |
| PY 1030.1 | understand different type of error like backlash error, parallax etc. and its role in making conclusions. | 3 | 3 | | 1 | 2 | 1 | | | 3 | 1 | | 1 | | | | |
| PY 1030.2 | gain knowledge on the behaviour of basic instruments like Slide Callipers, Vernier Callipers, screw gauge and spherometer etc. | 3 | 2 | | 2 | 2 | | | | 1 | 2 | | 1 | | | | |
| PY 1030.3 | acquire, analyse and process experimental data. | 1 | 1 | 1 | | | 3 | 2 | | 1 | 2 | 1 | 2 | | | | |
| PY 1030.4 | understand the facts and ideas in handling the practical applications of light, electricity sound and modern physics. | | | | 1 | 2 | | | 2 | 2 | 1 | | 1 | | | | |
| PY 1030.5 | acquire hands on skills on diverse experimental tools related to physics that are essential for | 1 | 3 | 1 | | | | 3 | | | | 2 | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | engineering students | | | | | | | | | | | | | | | | |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil & Chemical Engineering (SCCE)

Department of Chemical Engineering

Course Hand-out

Value, Ethics & Governance BB1101 [2 Credits] [2 0 0 2]

Session: July-Nov, 2019 | Faculty: Dr. Anjalee Narayan | Class: B.Tech–Chemical Engg–3rd SEM

**Introduction:** The course is offered to understand Moral Values and Ethics in personal as well as professional life. It is basic requirement of every human to be a good human being and a good citizen. It further imparts him basics of corporate governance so as to empower him to work technically and professionally in any organization with confidence and conviction and at the same time with honesty & integrity.

**A. Course Objectives:** At the end of the course, students will be able to

| | |
|---|---|
| BB1101.1 | Define the meaning and relevance of Value and Ethics and apply in personal & professional life. |
| BB1101.2 | Describe the importance of three Gunas for self-development, lifelong learning & growth. |
| BB1101.3 | Find issues and identify solutions related to Public & Private Governance systems. |
| BB1101.4 | Explain the relevance of Company's Act 2013 with reference to corporate world. |
| BB1101.5 | Explain the role and key objectives of organizational governance in relation to ethics and law. |
| BB1101.6 | Demonstrate the social & environmental responsibilities of corporate for sustainability, harmony and growth. |

**B. Program Outcomes and Program Specific Outcomes**

PROGRAM OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.3]. **Design/development of solutions**: Design a component system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.4]. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6]. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environment.

[PO.12]. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real applications using optimal resources as an Entrepreneur.

### C. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Mid Sem Exam I (Close Book) | 15 |
| | Mid Sem Exam II (Close Book) | 15 |
| | In class Quizzes/ Assignments<br>Students' Presentations | 20(Min 5 each)<br>10 |
| End Term Exam (Summative) | End Term Exam (Close Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |

| | |
|---|---|
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. |

D: **Syllabus:**

**Values**: Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life.

**Relevance of traits** like Personality, Attitude, Behaviour, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case Studies*.

**Governance:** Understanding of Public and Private sector Governance systems; Courts & CAG.

Public Sector Governance: Need, relevance, stakeholders.

Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance.

Projects on PPP mode-relevance & prospects.

**CSR**: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line

**Text / Reference Books**:


1. Professional Module of ICSI.
2. Ghosh B.N., Business Ethics & Corporate Governance, McGraw Hill.
3. Mandal S.K., Ethics in Business & Corporate Governance, McGraw Hill .
4. Ray C.K., Corporate Governance, Value & Ethics, Vaya Education of India
5. Chatterjee Abha, Professional Ethics, Oxford Publications.


***Suggestive Case Studies:**

1) Uphar Theatre Tragedy- Engineering Ethics
2) Bhopal Gas Tragedy- Operational Engineering Ethics
3) Satyam Case- Financial Reporting Ethics
4) Enron Case- Business Ethics
5) Neerav Modi Case- Financial Fraudulence *cases*

**D. Lecture Plan:**

| Lec No | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | **Introduction: Values:** Meaning & Relevance of value education | To acquaint and clear teacher's expectations and understand student expectations. Basics of Value Education | Lecture | BB 1101.1 | In class Quiz<br>Mid Term I<br>End Term Exam |
| 2 | Success: Meaning in perspective of morals & ethics | To understand the concept of success achieved with or without morals / ethics/ values | Lecture, case study | BB 1101.1 | In class Quiz<br>Mid Term I<br>End Term Exam |

| | | | | | |
|---|---|---|---|---|---|
| 3,4 | Professional Ethics & ethical dilemmas<br>Case study-Neerav Modi | To understand the role of professional ethics in the life & deal with dilemmas | Lecture | BB 1101.1 | In class Quiz, assignment<br>Mid Term I<br>End Term Exam |
| 5 | Three Gunas and their relevance, Nature and kinds of value with examples | Understand basic traits in one's personality, its causes and relevance with value based living. | Lecture | BB 1101.2 | In Class Quiz,<br>Mid Term I<br>End Term |
| 6,7 | Relevance of traits of individual like Personality, Attitude, Behaviour | To acquaint & develop positive traits of personality in oneself | Short stories, Lecture | BB 1101.2 | Class Quiz<br>assignment<br>Mid Term I<br>End Term |
| 8.9 | Ego, Character, introspection, Motivation | To acquaint & develop positive traits of personality in oneself and understand negative traits | Lecture Short stories | BB 1101.2 | In Class Quiz<br>Mid Term I<br>End Term |
| 10,11 | Leadership traits & 4Qs (PQ, IQ, EQ, SQ) | To realize importance of leadership and to imbibe in life | Lecture Short stories | BB 1101.2 | In Class Quiz<br>assignment<br>Mid Term I<br>End Term |
| 12,13 | Governance & its relevance<br>Case studies- Bhopal Gas & Uphar Cinema | To acquaint with the concept of Governance | Lecture | BB 1101.3 | In Class Quiz<br>Mid Term II<br>End Term |
| 14 | Public Sector Governance: Need, relevance, stakeholders | Understand various aspects of public sector governance | Lecture | BB 1101.3 | Class Quiz,<br>Mid Term II<br>End Term |
| 15 | Public Finance, Audit & Control | Understand basics of Public Finance, Check & balance | Lecture Case study | BB 1101.3 | Class Quiz,<br>assignment<br>Mid Term II<br>End Term |
| 16,17 | Private Sector Governance, proprietary & partnership firms and corporate, PPP mode projects | Understand meaning of proprietary & partnership in a firm / company and perspective in PPP mode | Lecture Short stories | BB 1101.3 & 1101.4 | Class Quiz<br>Mid Term II<br>End term |
| 18, 19 | Company' Act 2013 : Roles & Responsibilities of Directors & regulatory authorities | Explain various Regulations and practices of Corporate Governance internationally & understand key role of directors | Lecture | BB 1101.4 | Class Quiz<br>Mid Term II<br>End Term |
| 20,21 | Role of Ethics in Governance<br>Case studies- Satyam & Enron | Recognize the necessity of ethics & transparency in Governance | Movie : Gandhi | BB 1101.5 | Class Quiz,<br>assignment<br>Mid Term II<br>End Term |
| 22,23 | CSR: Relationship with Society, Philanthropy and Business strategy | To understand the relevance of giving back to society by a corporate & its importance in society | Lecture, case study | BB 1101.6 | Class Quiz,<br>End Term |
| 24 | CSR Policy, Triple Bottom Line | Understand the concept of TBL in organizational frameworks | Lecture case study | BB 1101.6 | Class Quiz<br>assignment<br>End Term |
| 25,26 | Students' Presentation | Recall contents and their importance through case studies. | Flipped Class | ALL | Class Quiz<br>End Term |

Course Articulation Matrix: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| BB1101.1 | Define the meaning and relevance of Value and Ethics and apply in personal & professional life. | | | | | | 1 | | 2 | | | | | | | |
| BB1101.2 | Describe the importance of three Gunas for self-development, lifelong learning & growth. | | | | | | 1 | | 2 | 1 | 1 | | 2 | | | 1 |
| BB1101.3 | Find issues and identify solutions related to Public & Private Governance systems. | | | | | | 1 | 1 | | 1 | 2 | | | | | |
| BB1101.4 | Explain the relevance of Company's Act 2013 with reference to corporate world. | | | | | | 1 | | 1 | 1 | | | | | | |
| BB1101.5 | Explain the role and key objectives of organizational governance in relation to ethics and law. | | | | | | 1 | | 2 | 1 | | | 1 | | | 1 |
| BB1101.6 | Demonstrate the social & environmental responsibilities of corporate for sustainability, harmony and growth. | | | | | | 1 | 3 | | | | 1 | 1 | | | 3 |

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Engineering Mathematics III | MA1310 | 3 Credits | 3 0 0 3

Session: Aug19 – Dec 19 | Faculty: Dr. Ram Naresh Saraswat | Class: Core course

**A. INTRODUCTION:** Mathematics is the backbone of engineering to develop analytical skills and capacity and to apply their knowledge to a wide range of problems relevant to modern industry. This course is a carefully selected blend of theory and real-world applications which prepares engineers for specialist professional employment.

**B. Course Outcomes:** At the end of the course, students will be able to

[MA1310.1] Apply knowledge of Laplace Transform, Fourier Transform, Z transform to solve real world problems.
[MA1310.2] Understand and use concept of probability theory and vector calculus in decision making and industry problems
[MA1310.3] Use of tensor and vector calculus to real world systems.
[MA1310.4] Develop analytical and logical thinking.
[MA1310.5] Recall and recognize the application of mathematics in engineering

**C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

Program Outcomes for B.Tech. in chemical engineering are as follows.

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**[PSO.2]. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 15 |
| | Sessional Exam II (Closed Book) | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

**E. SYLLABUS**

Vector Calculus: Gradient, divergence and curl, vector integrals, related theorems, introduction of tensors, Laplace Transforms: Transforms of elementary functions, inverse transforms, convolution theorem .Application of Laplace in solutions of differential equations Fourier series, Fourier Transform: Fourier sine and cosine transforms, Fourier integrals, study of heat and wave equations, Z Transform, Bessel and Legendre differential equations, Rodrigues formula, orthogonal properties of Bessel and Legendre polynomials, Problems: Probability, regression, least square principle of curve fitting, distributions – binomial, Poisson, normal.

**F. TEXTBOOKS**


1. Grewal, B. S., Higher Engineering Mathematics, Khanna Publishers, 2011.
2. Kreyszig, E., Advanced Engineering Mathematics, Wiley Eastern, 2012.

3. Pal and Bhunia, Advanced Engineering Mathematics, Oxford University Press, 2015

## G. REFERENCE BOOKS

4. Meyer, P. L., *Introduction to probability and statistical applications*, IBH 2010.

5. Hogg and Craig, *Introduction of Mathematical Statistics*, MacMillan, 2012.

## H. LECTURE PLAN

| LEC NO | TOPICS | Session outcome | Mode of Delivery | Corresponding CO | Mode of assessing CO |
|---|---|---|---|---|---|
| 1-6 | Laplace Transforms: Transforms of elementary functions, inverse transforms, convolution theorem .Application of Laplace in solutions of differential equations | Properties and example | Lecture | 1310.1 | Mid Term-1, End term |
| 6-9 | Fourier series, | Solve the problems and basic concept | Lecture + Tutorial | 1310.2 | Mid Term-1, End term |
| 9-12 | Fourier Transform: Fourier sine and cosine transforms, Fourier integrals, study of heat and wave equations, | Solve the problems and basic concept | Lecture + Tutorial | 1310.3 | Mid Term-1, End term, Assignment-1 |
| 12-15 | Probability, distributions – binomial, Poisson, | Solve the problems with basic concept | Lecture + Tutorial | 1310.3 | Mid Term-2, End term, Assignment-2 |
| 15-17 | Normal Distribution. | Basic concept and related problems on real life problems | Lecture | 1310.3 | Mid Term-2, End term |
| 17-22 | Vector Calculus: Gradient, divergence, and curl, | Basic concept and related problems on real life problems | Lecture + Tutorial | 1310.5 | Mid Term-2, End term |
| 22-25 | vector integrals, | Brief overview of the concept, Solve the problems and basic concept | Lecture | 1310.5 | Mid Term-2, End term, Assignment-3 |
| 25-29 | Gauss Divergence Theorem, Stokes Theorem and Green's Theorem | Solve the problems and basic concept | Lecture | 1310.4 | End term |
| 29-33 | Z Transform, | | Lecture | 1310.4 | End term |
| 33-37 | regression, least square principle of curve fitting, | Concept and problems related to industries | Lecture | 1310.4 | End term |
| 37-39 | Bessel and Legendre differential equations, Rodrigues formula, orthogonal properties of Bessel and Legendre polynomials, | Solve the problems and basic concept | Lecture | 1310.4 | End term |
| 39 - 41 | introduction of tensors, Tensor analysis | Basic concept and related problems on real life problems | Lecture + Tutorial | 1310.4 | End term, Assignment-4 |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO |
| MA 1310.1 | | Apply knowledge of Laplace Transform, Fourier Transform, Z -transform to solve real world problems | 2 | 1 | | 1 | | | | | | | |
| MA 1310.2 | | Understand and use concept of probability theory and vector calculus in decision making and industry problems | 2 | 1 | | 1 | 2 | | | | | | |
| MA 1310.3 | | Use tensor and vector calculus to real world problems | 2 | 1 | | 1 | 2 | | | | | | |
| MA 1310.4 | | Develop analytical and logical thinking | | 2 | 1 | 1 | 2 | 1 | 1 | 1 | | | |
| MA 1310.5 | | Recall and recognize the application of mathematics in engineering | | 1 | 1 | 1 | 2 | 1 | 2 | 1 | | | |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Organic Chemistry | CY1321 | 4 Credits | 3 1 0 4

Session: July'19 – Nov'19 | Faculty: Dr Nitu Bhatnagar | Class: Core course

**A. Introduction:** This course is offered by the Department of Chemistry as a core course. The purpose of this course is to provide key knowledge base and laboratory resources to prepare students as professionals in the field of chemistry, chemical industry and related fields. This course explains the behaviour of, and interactions between, matter and energy at both atomic and molecular levels.

**B. Course Outcomes:** At the end of the course, students will be able to:

[CY1321.1]. Understand the wide range of diversity in Organic Chemistry with the help of knowledge of basic organic chemistry along with practical approach.

[CY1321.2]. Explain various processes involved in understanding the mechanism of reactions.

[CY1321.3]. Impart the knowledge of carbohydrates and proteins.

[CY1321.4]. Identify the problems and applications of organic reactions.

[CY1321.5]. Understand stereochemistry of organic compounds and application of the concept in organic synthesis.

[CY1321.6]. Enhance the scientific skills of students for employability.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**[PO.1]. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
**[PO.2]. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
**[PO.3]. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
**[PO.4]. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
**[PO.5]. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
**[PO.6]. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
**[PO.7]. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
**[PO.8]. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
**[PO.9]. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
**[PO.10]. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**[PO.12]. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**[PSO.2]. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments, Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

Organic Reaction Mechanism: Reaction intermediates, Inductive effect, Mesomeric effect, Electromeric effect, Hyperconjugation, Types of reactions with mechanism-addition, substitution and elimination, Aromatic and Heterocyclic compounds. Industrially Important Organic reactions: Beckmann Rearrangement, Perkin reaction, Hofmann rearrangement, Reamer-Tiemann reaction, Cannizzaro reaction, Skraup synthesis, Diels-Alder reaction, Aldol condensation etc. Stereochemistry: Constitutional isomerism, Geometric isomerism, Syn-anti, Optical isomerism, Configuration- R,S and E,Z Conformation. Carbohydrates: Monosaccharaides, Disaccharides and Polysaccharides, Sources, Structure and Properties of Glucose, Fructose, Sucrose, Lactose, Starch and Cellulose. Amino acids & Proteins: Amino acids, Peptides, Proteins, Nucleic acids, Enzymes Organic Materials of industrial importance: Dyes-classification–modern theory of colour; Synthesis of methyl orange; Congo red, Malachite green, Indigo and Alizarin. Oils-Fats: Saponification value, Iodine and Acid value of oils, Solvent extraction of oils, Hydrogenation of oils, Soaps and Detergents, Petrochemicals.

## F. REFERENCE BOOKS

### TEXT BOOKS


1. Morrison B.R. and Boyd L.L., Organic Chemistry 6th Edition, ELBS, New Delhi, 2008.
2. Sykes P, A Guidebook to mechanism in Organic Chemistry, Pearson Education, 6th edition, 1986.
3. Finar I.L., Organic Chemistry Vol. I & II, Pearson Education, 6th edition, 2002.


### REFERENCE BOOKS


1. Sharma B.K. Industrial Chemistry, 16th edition, 2011.
2. Modern Analytical Chemistry, David Harvey, McGraw Hill, 1999.

**G. Lecture Plan:**

| Class Number | Topics | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introduction and Course Hand-out briefing | To acquaint and clear teachers expectations and understand student expectations | Lecture<br><br>Interaction | - | NA |
| 2 | Organic Reaction Mechanism: General Introduction, Classification of organic compounds, Bond Length, Bond Energy | To ascertain the interest and recapitulate the understanding and the existing knowledge about Organic Compounds | Interaction, Discussion & Question Answer Session | CO 1 | In Class Quiz ( Not Accounted) |
| 3 | Reaction intermediates, Inductive effect, Mesomeric effect | To make them understand the different types of effects | Interaction, Discussion | CO 1 | 1st Sessional |
| 4 | Electromeric effect, Hyperconjugation | To make them understand the different types of effects | Interaction, Discussion | CO 1 | 1st Sessional |
| 5 | Types of reactions with mechanism-Substitution Reactions: Nucleophilic substitution (SN1 & SN2) | To acquaint them with the mechanism of nucleophilic substitution reaction | Interaction, Discussion | CO 1 & CO 2 | 1st Sessional |
| 6 | Electrophilic and Free radical reactions | To make them understand the different types of reactions that involve reactive intermediates | Interaction, Discussion | CO 1 | 1st Sessional |
| 7 | Addition Reactions: Electrophilic, Nucleophilic and Free radical reactions | To make them understand the different types of reactions that involve reactive intermediates | Interaction, Discussion | CO 1 | Quiz 1st Sessional |
| 8 | Elimination: E1 and E2 Mechanism, Rearrangement Reactions | To make them understand the different types of reactions that involve reactive intermediates | Interaction, Discussion | CO 1 | 1st Sessional |
| 10 | Energy Consideration: Free energy, energy profile diagram, transition state and intermediate | To make them understand the reaction mechanism and the energy profile of the intermediates | Interaction, Discussion | CO 1 | Home Assignment |
| 11 | Reaction Intermediate: Carbocation, Carbanions, | To give them an understanding of reactive intermediates | Interaction, Discussion | CO 1 | 1st Sessional |
| 12 | Free radicals, carbene and benzynes | To give them an understanding of reactive intermediates | Interaction, Discussion | CO 1 | 1st Sessional |
| 13 | Industrially Important Organic reactions: Introduction, Beckmann Rearrangement | To conceptualize the understanding of reaction mechanisms of Industrially important reactions | Interaction, Discussion | CO 1 & CO 2 | 1st Sessional |
| 14 | Hofmann rearrangement, Perkin reaction | To conceptualize the understanding of reaction mechanisms of Industrially important reactions | Interaction, Discussion | CO 1 & CO 2 | 1st Sessional |
| 15 | Reimer-Tiemann reaction | To conceptualize the understanding of reaction mechanisms of Industrially important reactions | Interaction, Discussion | CO 1 & CO 2 | 1st Sessional |
| 16 | Cannizzaro reaction | To conceptualize the understanding of reaction mechanisms of Industrially important reactions | Interaction, Discussion | CO 1 & CO 2 | 1st Sessional |
| | MTE-I | | | | |
| 17 | Skraup synthesis | To conceptualize the understanding of reaction mechanisms of Industrially important reactions | Interaction, Discussion | CO 1 & CO 2 | 2nd Sessional |

| | | | | | |
|---|---|---|---|---|---|
| 18 | Diels-Alder reaction | To conceptualize the understanding of reaction mechanisms of Industrially important reactions | Interaction, Discussion | CO 1 & CO 2 | |
| 19 | Aldol condensation | To conceptualize the understanding of reaction mechanisms of Industrially important reactions | Interaction, Discussion | CO 1 & CO 2 | 2nd Sessional |
| 20 | Stereochemistry: Introduction, Classification of Stereoisomerism, Molecular Chirality | To make them understand the concept of chirality/stereochemistry | Interaction, Discussion | CO 5 & CO 6 | 2nd Sessional |
| 21 | Constitutional isomerism, Optical Isomerism: optical activity | To make them understand the concept of optical activity | Interaction, Discussion | CO 5 | 2nd Sessional |
| 22 | Diastereoisomers and meso compounds, | To make them understand the concept of diastereomers and meso compounds | Interaction, Discussion | CO 5 | Quiz |
| 23 | Fisher projection and Flying Wedge Formulae | To make them understand the Fisher projection and Flying Wedge Formulae | Interaction, Discussion | CO 1 & CO 5 | 2nd Sessional |
| 24 | Optical isomerism in Molecules without Chiral Centers | To make them understand the concept of optical isomerism | Interaction, Discussion | CO 5 | 2nd Sessional |
| 25 | Geometric isomerism, Syn-anti, Configuration- R,S and E,Z, | To make them understand the concept of geometrical isomerism | Interaction, Discussion | CO 5 | 2nd Sessional |
| 26 | Conformational Isomerism, Staggered and Eclipsed Conformations, Difference between Configuration and Conformation | To make them understand the concept of conformational isomerism | Interaction, Discussion | CO 5 | 2nd Sessional |
| 27 | Carbohydrates: Introduction, Classification and nomenclature, Monosaccharides | To recapitulate the understanding and the existing knowledge about carbohydrates | Interaction, Discussion Question Answer Session | CO 3 | 2nd Sessional |
| 28 | Mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses | To make them understand the mechanism of osazone formation | Interaction, Discussion | CO 3 | 2nd Sessional |
| 29 | Configuration of monosaccharides, Erythro and threo diastereomers | To make them understand configuration | Interaction, Discussion | CO 3 | 2nd Sessional |
| 30 | Conversion of glucose intro mannose, Formation of glcosides, ethers and esters | To make them understand the conversion of glucose | Interaction, Discussion | CO 3 | 2nd Sessional |
| 31 | Determination of ring size of monosaccharides, Cyclic structure of D (+)-glucose | To make them understand the cyclic structure of glucose | Interaction, Discussion | CO 3 | 2nd Sessional |
| | **MTE-2** | | | | |
| 32 | Mechanism of mutarotation, Structures of ribose and deoxyribose | To make them understand the concept of mutarotation | Interaction, Discussion | CO 3 | ET exam |
| 33 | Disaccharides (maltose, sucrose and lactose) | To give them an understanding of disaccharide | Interaction, Discussion | CO 3 | ET exam |
| 34 | Polysaccharides (starch and cellulose) | To give them an understanding of polysaccharide | Interaction, Discussion | CO 3 | ET exam |
| 35 | Amino Acids, Peptides, Proteins and Nucleic Acids: Introduction, Classification, structure and stereochemistry of amino acids, Acid-base behaviour isoelectric point and electrophoresis | To acquaint them with the structure and properties of amino acids | Student presentation, Interaction, Discussion | CO 4 | ET exam |
| 36 | Preparation and reactions of α-amino acids, Structure and nomenclature of peptides and | To acquaint them with the structure and properties of peptides | Student presentation, Interaction, Discussion | CO 4 | ET exam |

| | | | | | |
|---|---|---|---|---|---|
| | proteins, Classification of proteins, peptide structure determination | | | | |
| 37 | Peptide Synthesis, Structures of peptides and proteins, Levels of protein structure, Protein denaturation/ renaturation, | To acquaint them with the structure and proteins | Student presentation, Interaction, Discussion | CO 4 | ET exam |
| 38 | Nucleic acids: Introduction, constituents of nucleic acids, Ribonucleosides and ribonucleotides, The double helical structure of DNA | To acquaint them with the structure and properties of nucleic acids | Student presentation, Interaction, Discussion | CO 4 | ET exam |
| 39 | Enzymes Definition, classification of enzymes with one example, Mechanism of enzyme action. Lock and key mechanism, induced fit theory, Michaleis-Menten equation. Enzyme inhibition: competitive, uncompetitive and non-competitive, Biological functions of enzymes, Factors affecting enzyme | To acquaint them with the enzyme action | Interaction, Discussion | CO 4 | ET exam |
| 40 | Organic Materials of industrial importance: Dyes-classification–modern theory of colour | To acquaint them with the basics of dyes and the concept behind the relation of colour and structure | Interaction, Discussion | CO 1 & CO 4 | ET exam |
| 41 | Synthesis of methyl orange; Congo red, Malachite green, Indigo and Alizarin. | To make them understand the synthesis and working nature of different types of dyes | Interaction, Discussion | CO 1 & CO 4 | ET exam |
| 42 | Solvent extraction of oils, Hydrogenation of oils, Oils-Fats: Distinction between oil and fat | To make them understand the process involved in the extraction of oil | Interaction, Discussion | CO 1 & CO 4 | ET exam |
| 43 | Vegetable oil, Saponification value, Iodine and Acid value of oils | To make them understand the concept of different terms associated with the characteristics of fats/oils | Interaction, Discussion | CO 1 & CO 4 | ET exam |
| 44 | Hydrogenation of oils, Soaps and Detergents, Manufacture of soap, Analysis of oil, fats and waxes, Ecofriendly detergents-zeolite, Principal group of synthetic detergents | To make them understand the difference between soaps and detergents | Interaction, Discussion | CO 1 & CO 4 | ET exam |
| 45 | Petrochemicals, Manufacture of Petrochemicals, Alkylation, Dealkylation and Hydroalkylation | To make them understand the processes involved during the manufacture of petrochemicals | Interaction, Discussion | CO 1 & CO 4 | Home Assignment |
| 46 | Pyrolysis, Esterification, Halogenation and Hydrohalogenation | To make them understand the processes involved during the manufacture of petrochemicals | Interaction, Discussion | CO 1 & CO 4 | ET exam |
| 47 | Nitration, Oxidation, Oxo-hydroformation, Carbonylation, Polymerization | To make them understand the processes involved during the manufacture of petrochemicals | Interaction, Discussion | CO 1 & CO 4 | ET exam |
| | **End term Exam** | | | | |

**H. Course Articulation Matrix: (Mapping of COs with POs & PSOs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | *PSO1* | *PSO2* | *PSO3* |
| CY 1321.1 | Master the wide range of diversity in Organic Chemistry with the help of knowledge of basic organic chemistry along with practical approach | 2 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 |
| CY 1321.2 | Explain various processes involved in understanding the mechanism of reactions | 3 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 |
| CY 1321.3 | Impart the knowledge of carbohydrates and proteins | 2 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CY 1321.4 | Identify the problems and applications of organic reactions | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| CY 1321.5 | Skilled in solving problems of stereochemistry of organic compounds and application of the concept in organic synthesis | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 0 | 0 | 1 |
| CY 1321.6 | Enhance the scientific skills of students for employability. | 3 | 2 | 2 | 2 | 3 | 0 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 1 |

**1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

**MANIPAL UNIVERSITY JAIPUR**
School of Civil and Chemical Engineering
Department of Chemical Engineering
Course Hand-out
Chemical Process Calculations| CE1305 | 3 Credits | 3 0 0 3
Session: Jul'19 – Dec'19 | Faculty: Dr. Manisha Sharma | Class: Core course

## A. INTRODUCTION

This course on Chemical Process Calculations is a core course designed for the undergraduate students of Chemical Engineering. This course is intended to provide clear overview of field of chemical engineering and introduce the elementary principles involved in the analysis of chemical processes. It offers the fundamental knowledge required in solving the material and energy balances related to industrial problems and covers the concepts ranging from basic units and dimensions to simultaneous material and energy balances for reacting and non-reacting systems.

## B. COURSE OUTCOME

At the end of the course, students will be able to

**[CE1305.1]** Understand the fundamental concepts and calculations in chemical processes

**[CE1305.2]** Develop the skills to perform mass balance calculations on existing systems

**[CE1305.3]** Develop the skills to perform energy balance calculations

**[CE1305.4]** Evaluate the bubble point and dew points of multicomponent mixtures

**[CE1305.5]** Use the psychrometric charts to determine the properties of air required in solving vaporization and condensation problems

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

The Graduates of Chemical Engineering from MUJ will have:

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**PSO.1. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**PSO.2. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. ASSESSMENT PLAN

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/Quiz (Formative) | All assignments are to be solved and submitted, on/before deadline, on plain A4 size sheets only. Late submissions will not be entertained. | |
| Make up Assignments (Formative) | Students who miss a class will not be provided with any sort of makeup assignment or make up quiz. If you miss a lecture, you yourself have to study the topics that were covered during that particular lecture. However, you may contact the course coordinator for clarification of doubts, if any. | |

## E. SYLLABUS

Guidelines for Problem Solving; Review of Basic concepts – Process variables & properties, Degree of Freedom, **MATERIAL BALANCES**: Steady State Material Balances – in non-reacting systems and reacting system, Recycle & purge, elemental vs. species balance, combustion of fossil fuels. **MULTIPHASE EQULIBRIUM**: Single component and multicomponent phase equilibrium, Steady State Material balances in Multiphase systems. **ENERGY BALANCES**: Steady State Energy Balances – in non-reacting & reacting systems, De-Coupled & coupled mass & energy balances, Calculations for network of units with recycle & bypass, Process Flow sheeting with sequential modular calculations, Unsteady State Balances. **HUMIDIFICATION**: Terminology of humidity, Humidity charts, heating and cooling problems of moist air.

## F. TEXT BOOKS

T1. David M. Himmelblau and James B.Riggs, Basic Principles and Calculations in Chemical Engineering, 8th ed., Pearsons, TN, 2015

## G. REFERENCE BOOKS

R1. Richard M. Felder, Ronald W. Rousseau, Elementary Principles of Chemical processes, 3rd ed., Wiley, 2004

R2. B.I Bhatt and S.M Vora, Stoichiometry, 4th ed., Mc Graw Hill, 2004

## H. LECTURE PLAN

| LEC NO | TOPICS | SESSION OUTCOME | MODE OF DELIVERY | CORRESPONDING CO | MODE OF ASSESSING CO |
|---|---|---|---|---|---|
| 1 | Introduction to course and its significance | - | Lecture | - | |
| 2,3 | Dimensions and Units - Units and conversions and its significance, Fundamental and derived units, Conversion factors, Dimensional consistency | Fundamentals of units and conversions | Lecture | CE 1305.1 | Mid Term I, Assignment / Quiz & End Term |
| 4,5 | Basic chemical calculations | Concept of mole unit and equivalent weight, Definitions and Calculations for density, specific gravity concentration, interconversion of mole fraction and mass fraction, Temperature and pressure | Lecture | CE 1305.1 | Mid Term I, Assignment / Quiz & End Term |
| 6, 7 | Choosing a basis, Example problems | Choosing a basis | Lecture | CE 1305.1 | Mid Term I, Assignment / Quiz & End Term |
| 8,9 | Material Balances without chemical reactions - | Concept of open vs closed systems, steady vs unsteady state systems Degrees of freedom | Lecture | CE 1305.2 | Mid Term I, Assignment / Quiz & End Term |
| 10,11 | Material Balances without chemical reactions - | Material balance for single units | Lecture | CE 1305.2 | Mid Term I, Assignment / Quiz & End Term |
| 12-14 | Material Balances without chemical reactions - | Material balance for single units involving unit operations such as mixers, dryers, evaporators, crystallizers, absorbers and strippers | Lecture | CE 1305.2 | Mid Term I, Assignment / Quiz & End Term |
| 15-17 | Material Balances with | Concept of limiting and excess reactants, Extent of | Lecture | CE 1305.2 | Mid Term I, Assignment / |

| | | | | | |
|---|---|---|---|---|---|
| | chemical reactions - | reaction, Percentage conversion, yield, selectivity. | | | Quiz & End Term |
| 18 | Material Balances with chemical reactions - | Material balances involving single and multiple reactions using atomic/elementary balances and molecular/species balances | Lecture | CE 1305.2 | Mid Term II, Assignment / Quiz & End Term |
| 19 - 22 | Material Balances for multiple units – | Material balances with recycle, bypass and purge streams | Lecture | CE 1305.2 | Mid Term II, Assignment / Quiz & End Term |
| 22-25 | Combustion calculations - | Problems on combustion of coal, calorific value of fuels, Air requirement and flue gas analysis | Lecture | CE 1305.2, CE 1305.3 | Mid Term II, Assignment / Quiz & End Term |
| 26-28 | Ideal and Real Gases - | Concept of Ideal gas law and Henrys law. Real gas relationships and estimation of gas properties. Compressibility factor | Lecture | CE 1305.3 | Mid Term II, Assignment / Quiz & End Term |
| 29,30 | Multiphase Equilibrium - | Vapour liquid equilibrium, dew point and bubble point calculations | Lecture | CE 1305.4 | Mid Term II, Assignment / Quiz & End Term |
| 31,32 | Multiphase Equilibrium - | Use of Psychometric/humidity charts in problem solving | Lecture | CE 1305.4 | Mid Term II, Assignment / Quiz & End Term |
| 33,34 | Energy Balances without reactions - | First law of thermodynamics, heat capacities of gases and gaseous mixtures, Sensible heat changes in liquids and gases. | Lecture | CE 1305.3 | Assignment / Quiz & End Term |
| 35,36 | Energy Balances without reactions - | Enthalpy changes during phase transition | Lecture | CE 1305.3 | Assignment / Quiz & End Term |
| 37,38 | Energy Balances with Chemical Reactions - | Heat of reaction, heat of formation, heat of combustion | Lecture | CE 1305.3 | Assignment / Quiz & End Term |
| 39,40 | Energy Balances with Chemical Reactions - | enthalpy change associated with systems involving chemical reactions | Lecture | CE 1305.3 | Assignment / Quiz & End Term |
| 41,42 | Humidity charts and their use | Humidity calculations | Lecture | CE 1305.5 | Assignment / Quiz & End Term |

## I. COURSE ARTICULATION MATRIX (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | *PSO1* | *PSO2* | *PSO3* |
| CE 1305.1 | Understand the fundamental concepts and calculations in chemical processes | 3 | 1 | 2 | | 1 | 2 | | 1 | | | | 3 | 3 | 2 | |
| CE 1305.2 | Develop the skills to perform mass balance calculations on existing systems | 3 | 2 | 2 | | 1 | | 1 | | 1 | | | 3 | 3 | 2 | 1 |
| CE 1305.3 | Develop the skills to perform energy balance calculations | 3 | 2 | 2 | | 1 | | 1 | | 1 | | | 3 | 3 | 2 | 1 |
| CE 1305.4 | Evaluate the bubble point and dew points of multicomponent mixtures | 3 | 2 | 2 | 2 | 1 | 1 | | | | | | 1 | 1 | | 1 |
| CE 1305.5 | Use the psychrometric charts to determine the properties of air required in solving vaporization and condensation problems | 3 | 2 | 2 | 2 | | 2 | 1 | | | | | 2 | 1 | | 1 |

**1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Momentum Transfer| CE 1306/CE1302 | 3/4 Credits | 3 0 0 3 / 3 1 0 4

Session: July 19 – Dec 19 | Faculty: Dr. Harsh Pandey | Class: Core Course

## A. Introduction:

This course is one of the fundamental ground stones of Chemical Engineering. As a practicing chemical engineer you will have to deal with fluids that need to be transported from one part of the process plant to another. Therefore, in this course of momentum transfer you will be introduced to what a fluid is and how are they classified based on their flow properties. Following that you will study how to analyse a fluid in static state, kinematic state and dynamic state. This would include you getting to know different ways of measuring fluid flow and pumping of fluids. At the end of the course unit operations of agitation and mixing, flow through packing, filtration, fluidization and centrifugation will be introduced.

## B. Course Outcomes:

At the end of the course, students will be able to

**[CE1306.1]** Classify fluids based on rheology and calculate as well as correlate different fluid properties.

**[CE1306.2]** Correlate the concept of pressure with its measurement and use this knowledge to evaluate and design fluid static equipment like storage tanks and decanters.

**[CE1306.3]** Assess and design fluid flow measurement equipment based on Bernoulli's equation applying them to different flow problems.

**[CE1306.4]** Design, evaluate and develop the skill to understand the characteristics of different types of pumps/Blowers.

**[CE1306.5]** Design different fluid-based unit operations like agitation and mixing, flow through packing, filtration, fluidization and centrifugation.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Outcomes for B.Tech. in chemical engineering are as follows.

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**PSO.1. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.
**PSO.2. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.
**PSO.3. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes and Assignments. | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | No makeup for missed short quizzes or assignments or exam will be allowed, except in extenuating circumstances with prior permission of the instructor. The decision of the instructor in this regard will be final. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

Review of Navier-Stokes' (NS) equations; non-dimensionalization of NS equations; introduction to turbulence; analogies; correlations for fluid flow; Short introduction to non-Newtonian flows, Engineering Bernoulli Equation; f vs. NRe charts; K factors and equivalent lengths for various fittings; hydraulic diameter; Head vs. Q plots of centrifugal pumps; NPSH, cavitation and priming; pipeline system design including pseudo-steady state approximation; flow measurements; compressors and blowers. Compressible flows in conduits. Mixing and Agitation: Power consumption; mixing times; scale-up, Characterization of solids; fundamentals of two-phase flow; flow through packed beds and in fluidized beds (pressure drops, loading and flooding); pneumatic and hydraulic transportation. Filtration, Centrifuges and cyclones.

## F. TEXT BOOKS


1. de Nerves, N., "Fluid Mechanics for Chemical Engineers", McGraw Hill International.
2. McCabe, W.L., Smith, J.C., Harriott, P., "Unit operations of Chemical Engineering", McGraw Hill International.


## G. REFERENCE BOOKS


1. Foust, A.S., Wenzel, L.A., Clump, C.W., Maus, L., Andersen, L.B., "Principles of Unit Operations", John Wiley & Sons.
2. Coulson, J.M., Richardson J.F, Backhurst, J.R., Harker, J.H., "Coulson and Richardson's Chemical Engineering Volume 1: Fluid Flow, Heat Transfer and Mass Transfer" Butterworth-Heinemann/Elsevier.
3. Streeter, V.L., Wiley, B., "Fluid Mechanics", McGraw Hill International.
4. Bansal, R.K., "A Textbook of Fluid Mechanics and Hydraulic Machine", Khanna Publications.
5. Douglas, J.F., Gasiorek, J.M., Swaffield, J.A., "Fluid Mechanics", Pearson/Prentice Hall
6. Bennett, C.O., Myers, J.E., "Momentum, Heat, and Mass Transfer", McGraw Hill International.
7. Bird, R.B., Stewart, W.E., Lightfoot, E.N., "Transport Phenomena" John Wiley & Sons.
8. Geankoplis, C.J., "Transport Processes and Separation Process Principles", Prentice Hall of India.

**H. Lecture Plan**

| Lecture | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode Of Assessing CO |
|---|---|---|---|---|---|
| 1-3 | **Introduction to fluid mechanics** | Introduction to Fluid Mechanics, Continuum Hypothesis, Properties of fluids | Lecture | 1306.1 | Mid Term I, Assignment & End Term |
| 4-7 | **Fluid statics** | Hydrostatics, Application of hydrostatics, Buoyancy, Barometers, Manometers, Gravity settling, Centrifugal decanters, Illustration by examples. | Lecture | 1306.2 | Mid Term I, Assignment & End Term |
| 8-9 | **Dimensional analysis** | Raleigh Method, Buckingham π theorem, Introduction of dimensionless numbers | Lecture | 1306.1 | Mid Term I, Assignment & End Term |
| 10-11 | **Introduction to Fluid Dynamics** | The General Balance Equations, Mass Balance, Flow lines, Velocity Distribution, Steady and Unsteady state balance (one dimensional),- illustration by examples | Lecture | 1306.3 | Mid Term I, Assignment & End Term |
| 12 | **Differential analysis of Fluid Flow** | Euler's equation, Navier Stokes Equation | Lecture | 1306.3 | Mid Term II, Assignment & End Term |
| 13-17 | **Energy Balance Equations for Fluid Flow** | Energy and its different forms, First Law of Thermodynamics, Mechanical Energy Equation (Bernoulli's Equation), Correction factors for Bernoulli's Equation, Head form of Bernoulli's Equation | Lecture | 1306.3 | Mid Term II, Assignment & End Term |
| 18-21 | **Flow though Pipes** | Reynold's Experiment, Reynold's number, Laminar and Turbulent flow, Boundary layer theory, Flow through pipes, Friction factor, Moody's diagram- illustration by examples | Lecture | 1306.3 | Mid Term II, Assignment & End Term |
| 22-24 | **Applications of Bernoulli's equation** | Sudden Expansion and Sudden Contraction, Torricelli's Equation, Pitot tube, Venturi meters, Orifice meters, Rotameter, Losses in pipe systems- illustration by examples | Lecture | 1306.4 | Mid Term II, Assignment & End Term |
| 25-27 | **Pumps and Compressors** | Introduction to positive displacement pumps, centrifugal pumps, NPSH, Cavitation, Reciprocating blowers, centrifugal blowers- illustration by examples | Lecture | 1306.4 | Mid Term II, Assignment & End Term |
| 28-29 | **Pipe Networks** | Design of pipe networks- illustration by examples | Lecture | 1306.3 | Mid Term II, Assignment & End Term |
| 30-32 | **Mixing and Agitation** | Need for agitation and mixing, Types of agitation, Vortex and Baffles, Impeller types, Dimensionless numbers related to mixing, Scale up of agitated vessels, Static mixers, Jet mixers | Lecture | 1306.5 | End Term |
| 33-42 | **Solid Liquid Flows** | Concept of Drag & Coefficient of Drag, Stagnation point, Flow through bed of solids, Motion of particles in fluids, Fluidization, Sedimentation, Filtration | Lecture | 1306.5 | End Term |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1306.1 | Classify fluids based on rheology and calculate as well as correlate different fluid properties. | 3 | 3 | | 1 | | | | | | | | 2 | 1 | | 2 |
| CE 1306.2 | Correlate the concept of pressure with its measurement and use this knowledge to evaluate and design fluid static equipment of storage tanks and decanters. | 3 | 3 | 1 | | | 1 | 2 | 1 | | 1 | 1 | 2 | | | |
| CE 1306.3 | Assess and design fluid flow measurement equipment based on Bernoulli's equation applying them to different flow problems. | 3 | 3 | 2 | | | | 1 | | 1 | 1 | 1 | 2 | | | |
| CE 1306.4 | Design, evaluate and develop the skill to understand the characteristics of different types of pumps/Blowers. | 3 | 3 | 2 | | | | 2 | | 2 | 1 | 1 | 2 | 1 | | |
| CE 1306.5 | Design different fluid-based unit operations like agitation and mixing, flow through packing, filtration, fluidization and centrifugation. | 3 | 3 | | | | 1 | 3 | | 2 | 1 | 2 | 2 | 2 | 1 | |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Process Synthesis | CE 1307 | 3 Credits | 3 0 0 3

Session: July 19 – Dec 19 | Faculty: Ir. Nandana Chakinala | Class: Core Course

## A. Introduction:

This course on Process Synthesis is a core course designed for the undergraduate students of Chemical Engineering. This course emphasizes on the principles applied in developing a process from a potential point of view. The course presents heuristics and systematic tools for developing and screening potential process flow sheets. It provides insight in to the concepts of process design and development.

## B. Course Outcomes: At the end of the course, students will be able to

**[CE1307.1]** Synthesize the optimum reaction path from a set of alternatives.

**[CE1307.2]** Investigate the thermodynamic feasibility of chemical processes

**[CE1307.3]** Perform material and energy balances and synthesize the block flow and process flow diagrams for new processes.

**[CE1307.4]** Describe more widely used industrial separation methods and their basis of separations

**[CE1307.5]** Synthesize heat exchange networks to minimize external heating and cooling requirements

**[CE1307.6]** Develop the skill to interpret equilibrium data required in solving material balances

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
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| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes and Assignments. | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
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| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

Introduction to Process Systems Engineering; Strategy of Reaction Synthesis

**SYNTHESIS OF REACTION PATHS** - Engineering Data on Reaction Paths; Screening of Reaction Paths; Reaction Paths with Recycle; Conservation of Mass; Material Balancing Pathways

**SYNTHESIS OF REACTION FLOWSHEETS** - Synthesis of Material Flow; Species Allocation

**SEPARATIONS SYNTHESIS** - Introduction to Separation Technology; Solid-Solid separation methods; Liquid-Liquid separation techniques; Reduction of Separation Load; Selection of Separation Phenomena; Integration of Auxiliary Operations; Energy Balance; Sensible and Latent Heat; Heat of Chemical Reactions

**HEAT EXCHANGE NETWORK SYNTHESIS** - Heat energy management and Heat-Exchanger Networks; Case studies from chemical and petroleum processing plants

## F. TEXT BOOKS

**T1** Dale F. Rudd, Gary J. Powers, and Jeffrey J. Siirola, "Process Synthesis", Prentice-Hall international series in the physical and chemical engineering sciences, 1973.

**T2** Regina M. Murphy, "Introduction to chemical processes: Principles, Analysis, Synthesis", 1st ed., McGraw Hill education, 2013.

## G. REFERENCE BOOKS

**R1** Turton, Bailie, Whiting and Shaeiwitz, "Analysis, Synthesis and Design of Chemical Processes", 3rd ed., Prentice Hall India, 2009

**R2** Robin Smith, "Chemical Process: Design and Integration", 8th ed., Wiley, January 2005.

**R3** Warren D. Seider, J. D. Seader, Daniel R. Lewin, "Product and Process Design Principles: Synthesis, Analysis and Design", 2nd ed., Wiley, 2009

**Lecture Plan:**

| Lecture No. | TOPICS | Session Outcome | Mode of Delivery | Corresponding CO | Mode of assessing CO |
|---|---|---|---|---|---|
| 1 | Introduction to process synthesis | To understand the importance of process synthesis | Lecture | | |
| 2-3 | *The Engineering of process systems* - Elementary concepts of synthesis and analysis, Pattern of process synthesis | To acquaint the basic steps of process synthesis | Lecture | 1307.1 | Quiz, Mid term I, End Term |
| 4-5 | *Reaction path synthesis* – Engineering data on reaction paths, stoichiometric concepts | To acquaint the data required for reactor synthesis | Lecture | 1307.1 | Quiz, Mid term I, End Term |
| 6-8 | *Reaction path synthesis* – Generation consumption analysis, Economic screening of reaction paths, Atom economy, Process economy and associated heuristics | To synthesize the optimum reaction path from a set of alternatives | Lecture & Tutorial | 1307.1 | Quiz, Assignment, Mid term I & End term |
| 9-11 | *Reactor flow sheet synthesis* – Process flow calculations, Synthesis of new technology | To perform basic material balance calculations of reactor | Lecture & Tutorial | 1307.3 | Assignment, Mid term I & End term |
| 12 | *Reactor flow sheet synthesis* – system variables, system and stream specification | To acquaint the process variables and specifications used in flow calculations | Lecture | 1307.3 | Assignment, Mid term I & End term |
| 13-16 | *Reactor flow sheet synthesis* – reactor material balances, Species allocation from raw materials to reaction sites, recycle structure of flowsheet | To develop the recycle structure of flowsheet | Lecture | 1307.3 | Quiz, Assignment, Mid term I & End term |

| | | | | | |
|---|---|---|---|---|---|
| 17-19 | *Reactor flow sheet synthesis* - Chemical Equilibrium and kinetics | To estimate the equilibrium conversion of reactors | Lecture | 1307.2 | Quiz, Mid term II & End term |
| 20-22 | Introduction to separation technology, *Solid-solid separation techniques* - solubility differences, Density differences | To acquaint the basic principles of separations & To understand the property differences exploited in S-S separations | Lecture | 1307.4 | Quiz, Mid term II & End term |
| 23-24 | *Liquid-liquid separation techniques* - volatility differences | To acquaint the concept of volatility in distillation | Lecture | 1307.4 | Assignment, Mid term II & End term |
| 25-26 | *Liquid-liquid separation techniques* – solubility differences, *Gas-Gas separations* – Solubility differences | To describe and understand the L-L extraction and absorption process | Lecture | 1307.4 | Assignment, Quiz, Mid term II & End term |
| 27 | *Solid-liquid separations* – Solubility differences | To describe and understand the S-L extraction and absorption process | Lecture | 1307.4 | Quiz, Mid term II & End term |
| 28 | *Separation technology* – Phase equilibrium, equilibrium calculations and graphs | To interpret the equilibrium data used in separator flowsheet synthesis | Lecture & Tutorial | 1307.3 & 1307.6 | Assignment, Mid term II & End term |
| 29 | *Separator selection* – Heuristics, reduction of separation load | To synthesize separator flowsheet based on heuristics | Lecture | 1307.3 | Mid term II & End term |
| 30 | *Separator flowsheet synthesis* – Separator performance, process flow calculations | To perform material balance of separators | Lecture & Tutorial | 1307.3 | Assignment, Mid term II & End term |
| 31-33 | *Task integration* – Economy of processing plan, Preliminary design of equipment to reuse material and energy, industrial procedures for energy management | To develop the preliminary process flowsheet integrating reactions and separations | Lecture | 1307.6 | Quiz, Mid term II & End term |
| 34-35 | *Heat exchange network synthesis* – Process Energy calculations | To perform energy balance calculations of various systems | Lecture | 1307.3 & 1307.5 | Assignment, Quiz, End term |
| 36-38 | *Heat exchange network synthesis* – Preliminary synthesis of heat exchanger networks, industrial procedures for energy management, | To synthesize preliminary heat exchanger network based on heuristics | Case study & Tutorial | 1307.5 | End term |
| 39-40 | Case studies from chemical and petroleum processing plants | To apply the process synthesis principles for case studies | Case study Activity | 1307.3 | End term |

**H. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1307.1 | Synthesize the optimum reaction path from a set of alternatives | 3 | 1 | 1 | 1 | | 3 | | 2 | | 3 | 2 | 3 | 3 | | |
| CE 1307.2 | Investigate thermodynamic feasibility of chemical processes | 3 | 1 | 3 | | | 2 | | 1 | 2 | 3 | 2 | 3 | 3 | | 1 |
| CE 1307.3 | Perform material and energy balances and synthesize the block flow, process flow diagrams for new processes | 3 | 2 | 2 | | | 1 | | 2 | | 3 | 2 | 3 | 3 | 1 | 2 |
| CE 1307.4 | Describe more widely used industrial separation methods and their basis of separations | 3 | 3 | 1 | | | 2 | | 3 | | 3 | 2 | 3 | 3 | 1 | 1 |
| CE 1307.5 | Synthesize heat exchange networks to minimize external heating and cooling requirements | 3 | 3 | 2 | 2 | | 2 | | 2 | 1 | 3 | 2 | 3 | 3 | 2 | 2 |
| CE 1307.6 | Develop the skill to interpret the equilibrium data required in solving material balances | 3 | 2 | | | | 2 | | 2 | | 3 | 2 | 3 | 3 | | 1 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

**MANIPAL UNIVERSITY JAIPUR**

School of Basic Sciences

Department of Chemistry

Course Hand-out

Engineering Materials | CE 1304 | 3 Credits | 3 0 0 3

Session: July 19 – Nov 19 | Faculty: Dr. Veena Dhayal | Class: B. Tech. (Chemical) III Sem.

**A. Introduction:** This course is offered by Dept. of Chemical Engineering as a core course, targeting students who wish to pursue research & development in industries or higher studies in field of engineering materials, including structure of material, ferrous and non- ferrous materials, electrical and magnetic properties of materials and gives an introductory level knowledge on classification of materials, crystal structure, properties and treatments of material. Students are expected to have background knowledge on learning of smart & nano-materials and their potential applications.

**B. Course Outcomes:** At the end of the course, students will be able to

**[CE 1304.1]** Analyse the materials classification, properties and 3- dimensional crystal structure and its potential applications in daily life.

**[CE 1304.2]** Determine the various engineering techniques to improve skills for modification of the surface properties of materials to increase their performance.

**[CE 1304.3]** Analyse the formation of energy band concept of conductor, insulator and semi-conductor and its applications

**[CE 1304.4]** Recognize different heat treatment techniques and judge the best way to improve physical and mechanical properties of materials

**[CE 1304.5]** Analyse the properties of smart nano-engineered & composites materials and apply them to solve real-life problems in engineering.

**C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

The graduates of chemical engineering from MUJ will have:

**[PO.1].** **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**[PO.2].** **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**[PO.3].** **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**[PO.4].** **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**[PO.5].** **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**[PO.6].** **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**[PO.7].** **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**[PO.8].** **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**[PO.9].** **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**[PO.10].** **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**[PO.11].** **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**[PO.12].** **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Degree Specific Outcomes for chemical engineering are as follows:

**[PSO.1].** **Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**[POS.2].** **Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3].** **Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

**STRUCTURE OF MATERIALS**-crystal structure, substructure, microstructure; **MATERIALS CLASSIFICATIONS** –engineering standards, material selection (CES type packages); **MATERIAL PROPERTIES** – mechanical, electrical, physical, corrosion, etc. properties; **MATERIAL TREATMENT** –Heat treatment**,** Various types of heat treatment such as Annealing, Normalizing, Quenching, Tempering (Austempering, Martempering), and various case hardening processes, surface treatment, etc.; **FERROUS MATERIALS**-Various types of carbon steels, alloy steels and cast irons, its properties and uses, effects of different alloying elements, super alloys; **NON-FERROUS METALS AND ALLOYS**-Non-ferrrous metals such as Cu, Al, Zn, Cr, Ni etc. and its applications, Various type of Brass and Bronze, bearing materials, its properties and uses. Aluminum alloys such as Duralumin; **CERAMICS** – classification, characterization, properties; **PLASTICS** – Various types of polymers/plastics and its applications, Mechanical behaviour and processing of plastics, Future of plastics; **COMPOSITE MATERIALS** – structure, properties, classification, processing; **OTHER MATERIALS:** Brief description of other material such as optical and thermal materials, Introduction to Smart materials & Nano-materials and their potential applications; **ELECTRIC PROPERTIES, SEMICONDUCTORS AND SUPER CONDUCTORS**-Energy band concept of conductor, insulator and semi-conductor. Intrinsic & extrinsic semi-conductors. Super conductivity and its applications; **MAGNETIC PROPERTIES**-Concept of magnetism - Dia, para, ferro Hysteresis. Soft and hard magnetic materials; **SURFACE ENGINEERING AND APPLICATIONS** – techniques, coatings, processing and heat treatment.

## F. TEXT BOOKS


1. W. D. Callister, Fundamentls of Materials Science and Engineering, Wiley (2007), 9th Edition
2. V. Raghvan, Materials Science and Engineering, 5th Edition, Phi Learning (2013)
3. C. Kittle, Introductin to Solid State Physics, Wiley (2007)


## G. REFERENCE BOOKS


1. Structure and Bonding in Crystalline Materials, Cambridge University Press (2001)
2. V. Gerold Materials Science and Technology, Volume 1, VCH Publication (1992)

**H. Lecture Plan:**

| LEC NO | TOPICS | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| **1** | Introduction to Engineering materials and their applications in real life | To acquaint and clear teachers expectations and understand student expectations | Interaction, discussion | - | NA |
| 2 | Materials classifications: engineering standards, material selection (CES type packages) | Analyse the materials classification and its potential applications in daily life. | Lecture, Interaction, Discussion | CO 1 | 1st Sessional, ET Exam, Home Assignment |
| 3 | Structure of materials- crystal structure, substructure, microstructure materials | Thorough understanding of 3- dimensional crystal structure at microlevel | Interaction, Discussion & Question Answer Session | CO 1 | 1st Sessional, ET Exam, Home Assignment |
| 4, 5 | Material treatment –Heat treatment, various types of heat treatment such as Annealing, Normalizing, | Recognize different heat treatment techniques, Annealing, Normalizing | Lecture, Interaction, Question Answer Session | CO 4 | 1st Sessional, ET Exam, Home Assignment |
| 6 | Quenching, Tempering (Austempering, Martempering), | Recognize heat treatments, Quenching, Tempering (Austempering, Martempering | Lecture, Interaction, Question Answer Session | CO 4 | 1st Sessional, ET Exam, Home Assignment |
| 7 | Various case hardening processes, surface treatment, etc.; | Judge the best way to improve surface properties of materials | Lecture, Interaction, Question Answer Session | CO 2 | 1st Sessional, ET Exam, Home Assignment |
| 8 | Ferrous materials: Various types of carbon steels, alloy steels and cast irons | Classification of steel based on their compositions | Lecture, Interaction, Question Answer Session | CO 1, CO 2 | 1st Sessional, ET Exam, Home Assignment |
| 9, 10 | Properties of Ferrous materials: mechanical, electrical, physical, corrosion | Properties of ferrous materials based on their compositions | Lecture, Interaction, Question Answer Session | CO 1, CO 3 | 1st Sessional, ET Exam |
| 11, 12 | Applications of Ferrous materials, effects of different alloying elements, super alloys; | Effect of alloying elements on the properties of materials and their applications. | Lecture, Interaction, Question Answer Session | CO 1 | 1st Sessional, ET Exam, |

| | | | | | |
|---|---|---|---|---|---|
| 13 | Non-Ferrous metals such as Cu, Al, Zn, Cr, Ni etc. and its applications and alloys | Classification of non-ferous metals based on their compositions | Lecture, Interaction, Question Answer Session | CO 1 | 1st Sessional, ET Exam, |
| 14 | Revision | | | | |
| Ist Sessional Exam | | | | | |
| 15, 16 | Various type of Brass and Bronze bearing materials and its properties and uses, Aluminum alloys such as Duralumin | Compositions of brass and bronze, their properties and applications | Lecture, Interaction, Question Answer Session | CO 1 | 2nd Sessional, ET Exam, Class test |
| 17 | Classification and characterization of ceramics, Properties of Ceramics, | Knowledge about ceramics and their classifications and properties | Lecture, Interaction, Question Answer Session | CO 5 | 2nd Sessional, ET Exam, Class test |
| 18 | Plastics – Various types of polymers/plastics and its applications | Knowledge about polymer. Plastics and its applications | Lecture, Interaction, Question Answer Session | CO 5 | 2nd Sessional, ET Exam, Class test |
| 19 | Mechanical behaviour and processing of plastics, Future of plastics | Mechanical properties of plastics | Lecture, Interaction, Question Answer Session | CO 5 | 2nd Sessional, ET Exam, Class test |
| 20 | Composite materials – classification, processing, structure, properties of Composite materials | Knowledge about composites, its classifications, properties and processing | Lecture, Interaction, Question Answer Session | CO 2, CO 5 | 2nd Sessional, ET Exam, Class test |
| 21, 22 | Other materials: Brief description of other material such as optical and thermal materials, | Knowledge about some important optical and heat resistive materials | Lecture, Interaction, Question Answer Session | CO 3, CO 5 | 2nd Sessional, ET Exam, Class test |
| 23 | Class test | | | | |
| 24, 25 | Introduction to Smart materials & nanomaterials, Synthesis and Characterization of nanomaterials | Knowledge about some smart and nano materials, their synthesis and various characterization techniques | Lecture, Interaction, Question Answer Session | CO 5 | 2nd Sessional, ET Exam |
| 26 | Electric properties of nanomaterials, | Major electrical properties of nanomaterials | Lecture, Interaction, Question Answer Session | CO 3 | 2nd Sessional, ET Exam |
| 27, 28 | Potential applications of Nanomaterials | Various applications of nanomaterials | Lecture, Interaction, Question Answer Session | CO 5 | 2nd Sessional, ET Exam |
| 29, 30 | Semiconductors and Super conductors, Energy band concept of conductor, | Knowledge about conductivity and band theory | Lecture, Interaction, Question Answer Session | CO 3 | 2nd Sessional, ET Exam |

| | | | | | |
|---|---|---|---|---|---|
| 31, 32 | insulator and semi-conductor, Intrinsic & extrinsic semi-conductors | Classification of conductors | Lecture, Interaction, Question Answer Session | CO 3 | 2nd Sessional, ET Exam |
| 33 | Superconductivity and its applications | Knowledge about superconductivity and its applications | Lecture, Interaction, Question Answer Session | CO 3 | 2nd Sessional, ET Exam |
| 2nd SESSIONAL EXAMINATION | | | | | |
| 34, 35, 36 | Magnetic properties-Concept of magnetism, Diamagnetism, Paramagnetism, | Classification of materials based on magnetic properties | Lecture, Interaction, Question Answer Session | CO 1 | ET Exam, Quiz |
| 37 | Ferromagnetism, Hysteresis | Knowledge about ferromagnetic materials | Lecture, Interaction, Question Answer Session | CO 1 | ET Exam, Quiz |
| 38, 39 | Soft and hard magnetic materials, Surface engineering of nanomaterials: techniques, coatings | Knowledge about surface engineering of nanomaterials, coating techniques | Lecture, Interaction, Question Answer Session | CO 1, CO 2 | ET Exam, Quiz |
| 40 | Quiz 1 | | | | |
| 41 | Surface engineering of nanomaterials: processing and heat treatment. | Surface engineering by heat treatment | Lecture, Interaction, Question Answer Session | CO 2 | ET Exam |
| 42 | Properties and applications of surface engineering of nanomaterials | Various applications of surface engineering of nanomaterials | Lecture, Interaction, Question Answer Session | CO 2 | ET Exam |
| 43 | Revision | | | | |
| | END SEMESTER EXAMINATION | | | | |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | Statement | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1304.1 | Analyse the material classification, properties and 3-dimentional crystal structure and its potential applications in daily life. | 1 | 1 | 1 | 1 | | | 1 | 1 | | 1 | 1 | | 1 | 1 | |
| CE 1304.2 | Determine the various engineering techniques to improve skills for modification of the surface properties of materials to increase their performance. | 2 | 1 | 2 | | 2 | | 1 | | 1 | | 1 | 1 | 1 | 2 | 1 |
| CE 1304.3 | Analyse the formation of energy band concept of conductor, insulator and semi-conductor and its applications. | 2 | 3 | | 1 | | 1 | | | | | | 1 | 1 | 1 | 1 |
| CE 1304.4 | Recognize different heat treatment techniques and judge the best way to improve physical and mechanical properties of materials. | 1 | 2 | 2 | 1 | | | 2 | | | 2 | 1 | 2 | | 1 | 1 |
| CE 1304.5 | Analyse the properties of smart nano-engineered & composites materials and apply them to solve real life problems in engineering. | 2 | | 2 | 1 | | 1 | 2 | 1 | 1 | 1 | | 1 | 1 | 2 | 1 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Transport Phenomena | CE 1405/1501 | 3/4 Credits | 3/3 0/1 0/0 3/4

Session: Jan 20 – May 20 | Faculty: Dr Gaurav Kataria | Class: IV Semester

**A. Introduction:** This course is an introductory course in Transport Phenomena whereby the student shall be exposed to the various major areas and their applications. The student shall be armed with the basic tools and understanding of the field. The 'premium' in this course shall be on 'thinking' rather than doing things 'mechanically' so that the student is able to apply the various concepts to different situations, other than the ones encountered during the course, as and when the need arises.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1405.1].** Identify transport properties and analyze the mechanisms of momentum, energy and mass transport.

**[1405.2].** Develop the skills to select, locate and orient coordinate systems for transport phenomena problems.

**[1405.3].** Generate the skills to formulate the differential forms of the equations of change for momentum, heat and mass transfer problems for steady-state and unsteady flows.

**[1405.4].** Develop the skills to identify the analogies between momentum, heat and mass transfer problems.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Outcomes for B.Tech. in chemical engineering are as follows.

The Graduates of Chemical Engineering from MUJ will have:

**PO.1** A thorough knowledge of the basic science, engineering and mathematics and apply that to the underline practice of Chemical Engineering

**PO.2** Ability to apply these basic principles to solve real world problems in a broad range of career paths

**PO.3** The skills of making smart decisions on process feasibility based in technical and economic evaluation

**PO.4** The ability to appreciate the social, ethical, cultural, environmental and safety issues related to chemical engineering profession

**PO.5** The ability to develop experimental procedure/protocol to test hypothesis and analysis meaningful interpretation of the generated data

**PO.6** The skill to generate sustainable engineering solutions to societal and industrial problems

**PO.7** Proficiency to use computational tools for problem solving

**PO.8** The ability to communicate effectively (technical and non-technical context) in written and oral form

**PO.9** Skills to work effectively and professionally in multi-disciplinary groups

**PO.10** The ability to work effectively and professionally on projects both independently and as a part of a group/team

**PO.11** The ability to be self-learners and lifelong learners

**PO.12** The motivation to develop and lead entrepreneurial projects for societal benefit

Degree Specific Outcomes for chemical engineering are as follows:

**PSO.1** Concept to Commissioning: The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant.

**POS.2** Process Intensification: graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3** Specialization: Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home & Class Assignment (Formative) | Home and class assignments are an integral part of this course – you can only learn by doing! Home works will be assigned in between the lectures along with the due date for handing it over. Assignments will also be given during lecture hours where students will be asked to solve open-ended problems/case studies within stipulated time. No late assignments handed after the due date shall be accepted under any circumstance. It is expected that the students shall work on the assignments independently and not 'copy' the solutions from each other. Students are encouraged to discuss problems with their instructor in lecture hours. Students are advised to meet the instructor in case of any difficulty related to assignments and course related matters. Total 10 assignments will be given as a part of home and class assignments. | |

## E. SYLLABUS

**Momentum Transport-** Viscosity and mechanisms of momentum transport, shell momentum balances and velocity distribution in laminar flow, the equations of change for isothermal systems, velocity distributions with more than one independent variable, velocity distribution in turbulent flow, interphase transport in isothermal systems, macroscopic balances for isothermal flow systems

**Energy Transport-** Thermal conductivity and mechanisms of energy transport, shell energy balances and temperature distributions in solids and laminar flow, the equations of change for nonisothermal systems, temperature distributions with more than one independent variable, temperature distribution in turbulent flow, interphase transport in nonisothermal systems, macroscopic balances for nonisothermal systems, energy transport by radiation

**Mass Transport-** Diffusivity and mechanisms of mass transport, concentration distributions in solids and laminar flow, equations of change for multicomponent systems, interphase transport in nonisothermal mixtures, macroscopic balances for multicomponent systems.

## F. TEXT BOOKS

"Transport Phenomena" (Second Edition), R B Bird, W E Stewart, E E Lightfoot, John Wiley & Sons, (2007).

## G. REFERENCE BOOKS

"Analysis of Transport Phenomena" (Second Edition), W M Deen, Oxford University Press, (2013).

"Transport Processes and Separation Process Principles: (includes Unit Operations)" (Forth Edition), C Geankoplis, Prentice Hall of India, (2004).

"Introduction to Transport Phenomena" W J Thompson, Prentice Hall, (1999).

**H. Lecture Plan:**

| Lecture No. | Topics | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1. | Introduction ; Newton's Law of Viscosity | Understand the role of viscosity in the momentum transfer. | Lecture | 1504.1 | Mid Term I<br>End Term |
| 2. | Non-Newtonian Fluids; Pressure-Temperature Dependence of Viscosity | Distinguishing the types of fluids based on viscosity. | Lecture | 1504.1 | Mid Term I<br>End Term |
| 3. | Shell Momentum Balances: Boundary Conditions; Flow of a Falling Film | Understand the use of shell momentum balance. | Lecture | 1504.1/3 | Mid Term I<br>End Term |
| 4. | Flow through a Circular Tube | Understand the use of shell momentum balance. | Lecture | 1504.1/2/3 | Mid Term I<br>End Term |
| 5. | Flow through an Annulus. | Understand the use of shell momentum balance. | Lecture | 1504.1/2/3 | Mid Term I<br>End Term |
| 6. | The Equation of Continuity; The Equation of Motion | Generalizing the shell momentum balance equations. | Lecture | 1504.1/2/3 | Mid Term I<br>End Term |
| 7. | Equations of Change in Curvilnear Coordinates; Uses of Equations of Change to set up Steady Flow Problems | Generalizing the shell momentum balance equations. | Lecture | 1504.1/2/3 | Mid Term I<br>End Term |
| 8. | Dimensional Analysis of the Equations of Change | Generalizing the shell momentum balance equations. | Lecture | 1504.1/2/3 | Mid Term I<br>End Term |
| 9. | Unsteady Viscous Flow | Understanding the unsteady flow problems. | Lecture | 1504.1 | Mid Term I<br>End Term |
| 10. | Fluctuations and Time-Smoothed Quantities; Time-Smoothing of the Equations of Change for an incompressible Fluid | Understanding the solution of unsteady flow problems. | Lecture | 1504.2/3 | Mid Term I<br>End Term |
| 11. | Definition of Friction Factors; Friction Factors for Flow in Tubes; Friction Factors for Flow Around Spheres | Understanding the role of friction factor in the transport phenomenon. | Lecture | 1504.1 | Mid Term I<br>End Term |
| 12. | The Macroscopic Mass Balance; The Macroscopic Momentum Balance | Distinguishing the macroscopic and microscopic problems. | Lecture | 1504.1/3 | Mid Term I<br>End Term |
| 13. | The Macroscopic Mechanical Energy | Distinguishing the macroscopic and | Lecture | 1504.1/3/4 | Mid Term I<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| | Balances; Estimation of Friction Loss | microscopic problems. | | | |
| 14. | Use of the Macroscopic Balance to set up Steady Flow Problems | Distinguishing the macroscopic and microscopic problems. | Lecture | 1504.1/3/4 | Mid Term I<br>End Term |
| 15. | Review Lecture | | Lecture | | Mid Term I<br>End Term |
| **MID-TERM I** | | | | | |
| 16. | Fourier's Law of Heat Conduction; Temperature and Pressure Dependence of Thermal Conductivity in Gases and Liquids | Understand the basic concept of heat transfer. | Lecture | 1504.1 | Mid Term II<br>End Term |
| 17. | Shell Energy Balances; Boundary Conditions; Heat Conduction with an Electrical Heat Source | Understand the use of shell energy balance. | Lecture | 1504.1/3 | Mid Term II<br>End Term |
| 18. | Heat Conduction with a Viscous Heat Source | Understand the use of shell energy balance. | Lecture | 1504.1/3 | Mid Term II<br>End Term |
| 19. | Heat Conduction through Composite Walls: Addition of Resistances | Understand the use of shell energy balance. | Lecture | 1504.1/3 | Mid Term II<br>End Term |
| 20. | Forced Convection; Free Convection | Distinguishing the solution of forced and free convection. | Lecture | 1504.1/3 | Mid Term II<br>End Term |
| 21. | The Equations of Energy; The Energy Equation in Curvilinear Coordinates | Generalizing the shell energy balance equations. | Lecture | 1504.1/2/3 | Mid Term II<br>End Term |
| 22. | Summary of the Equations of Change; Use of the Equations of Change to set up Steady Flow Heat Transfer Problems | Generalizing the shell energy balance equations. | Lecture | 1504.1/2/3 | Mid Term II<br>End Term |
| 23. | Dimensional Analysis of the Equations of Change | Generalizing the shell energy balance equations. | Lecture | 1504.1/2/3 | Mid Term II<br>End Term |
| 24. | Unsteady Heat Conduction in Solids | Understanding the unsteady heat flow problems. | Lecture | 1504.1/3 | Mid Term II<br>End Term |
| 25. | Definition of the Heat Transfer Coefficient; Heat Transfer Coefficients for Forced Convection in Tubes; Heat Transfer Coefficient for Forced Convection around Submerged Objects | Understanding the common terms of heat transfer and their role in the chemical engineering applications. | Lecture | 1504.1/3/4 | Mid Term II<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 26. | Heat Transfer Coefficients for Free Convection | Understanding the heat transfer concept in free convection. | Lecture | 1504.1/3 | Mid Term II<br>End Term |
| 27. | Spectrum of Electromagnetic Radiation; Absorption and Emission at Solid Surfaces; Planck's Law; Wien's Law; Stefan-Boltzmann Law | Understanding the basics of radiation heat transfer. | Lecture | 1504.1 | Mid Term II<br>End Term |
| 28. | Direct Radiation between Black Bodies in Vacuo at Different Temperatures | Understanding the basics of radiation heat transfer. | Lecture | 1504.1/3 | Mid Term II<br>End Term |
| **MID-TERM II** | | | | | |
| 29. | The Macroscopic Energy Balance; The Macroscopic Mechanical Energy Balance (Bernoulli Equation) | Distinguishing the macroscopic and microscopic heat problems. | Lecture | 1504.1/3 | End Term |
| 30. | Summary of the Balances for Pure Fluids; Use of the Macroscopic Balances for Solving Steady-State Problems (458-460) | Distinguishing the macroscopic and microscopic heat problems. | Lecture | 1504.1/2/3 | End Term |
| 31. | Definition of Concentrations, Velocities, and Mass Fluxes; Fick's Law of Diffusion; Temperature and Pressure Dependence of Mass Diffusivity | Defining basic terms of mass transfer in transport phenomenon. | Lecture | 1504.1/3/4 | End Term |
| 32. | Shell Mass Balances; Boundary Conditions; Diffusion through a Stagnant Film | Understand the use of shell mass balance. | Lecture | 1504.1/3 | End Term |
| 33. | Diffusion with Heterogeneous Chemical Reaction; Diffusion with Homogeneous Chemical Reaction | Understand the use of shell mass balance. | Lecture | 1504.1/3 | End Term |
| 34. | Diffusion in to a Falling Liquid Film: Forced Convection Mass Transfer | Understand the use of shell mass balance. | Lecture | 1504.1/3 | End Term |
| 35. | The Equations of Continuity for a Binary Mixture; The Equation of Continuity of A in Curvilinear Coordinates; The Multicomponent Equations of Change in Terms of Fluxes | Generalizing the shell mass balance equations. | Lecture | 1504.1/3 | End Term |

| | | | | | |
|---|---|---|---|---|---|
| 36. | Dimensional Analysis of the Equations of Change for a Binary Isothermal Fluid Mixture | Generalizing the shell mass balance equations. | Lecture | 1504.1/2/4 | End Term |
| 37. | Definition of Binary Mass Transfer Coefficients in One Phase; Correlations of Binary Mass Transfer Coefficients in One Phase at Low Mass Transfer Rates | Understanding the binary mass transfer terms. | Lecture | 1504.1 | End Term |
| 38. | Definition of the Transfer Coefficients for High Mass Transfer Rates | Understanding the high mass transfer concepts. | Lecture | 1504.1/4 | End Term |
| 39. | The Macroscopic Mass / Momentum / Energy Balances for Multicomponent Systems; Use of Macroscopic Balances to Solve Steady State Problems | Distinguishing the macroscopic and microscopic mass transfer problems. | Lecture | 1504.1/3 | End Term |
| 40. | Use of Macroscopic Balances to Solve Steady State Problems | Solving the macroscopic mass transfer problems. | Lecture | 1504.1/3 | End Term |
| **END-TERM EXAMINATION** | | | | | |

## I. Course Articulation Matrix: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1405.1 | Identify transport properties and analyze the mechanisms of momentum, energy and mass transport. | 3 | 3 | | | 1 | | 1 | | 2 | | 1 | | 3 | 1 | |
| CE 1405.2 | Develop the skills to select, locate and orient coordinate systems for transport phenomena problems. | 3 | 3 | | | | | 1 | | 1 | | 2 | | 2 | 1 | |
| CE 1405.3 | Generate the skills to formulate the differential forms of the equations of change for momentum, heat and mass transfer problems for steady-state and unsteady flows. | 3 | 3 | | | 3 | | 2 | | 2 | | 2 | | 3 | 2 | |
| CE 1405.4 | Develop the skills to identify the analogies between momentum, heat and mass transfer problems. | 3 | 2 | | | 1 | | 1 | | 2 | | 2 | | 1 | 2 | |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Chemical Engineering Thermodynamics | CE 1406 | 3 Credits | 3 0 0 3

Session: Jan 20 – May 20 | Faculty: Anand Chakinala | Class: B. Tech. (Chemical) IV Semester

**A. Introduction:** This course intends to present thermodynamics from chemical engineering view point. It covers the laws of thermodynamics, thermodynamic relations, Solution thermodynamics, phase equilibrium and chemical reaction equilibrium. The key elements include the adaptation of thermodynamic laws to different flow processes, description of phase equilibrium and chemical equilibrium and their applications.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1406.1].** Apply the basic laws of thermodynamics to calculate heat and work requirement for industrial processes
**[1406.2].** Analyse and evaluate data from PVT behaviour of fluids and ideal gas systems
**[1406.3].** Apply mass, energy and entropy balances to flow processes
**[1406.4].** Evaluate and apply the concepts of phase equilibrium
**[1406.5].** Evaluate and apply the physical and chemical equilibrium
**[1406.6].** Apply the knowledge of thermodynamics to the reacting and non-reacting processes

**C. Program outcomes and program specific outcomes**

Program Outcomes for B.Tech. in chemical engineering are as follows.

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full-scale plant taking into account environmental concerns.

**[PSO.2]. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes, Assignments, Projects, Case Studies (Accumulated and Averaged) | 30 |
| End Term Exam | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments | No make-up for missed short quizzes/assignments or exam will be allowed except in extenuating circumstances, with prior permission of the instructor(s), and the decision of the instructor(s) in this regard shall be final. | |
| Homework/ Home Assignment/ Project | Home works will be assigned in between the lectures along with the due date for handing it over. No late assignments handed after the due date shall be accepted under any circumstance. It is expected that the students shall work on the assignments independently and not 'copy' the solutions from each other. A case study is given which is assessed in form of individual reports submitted. | |

**E. Syllabus**

Review of I and II Laws of Thermodynamics, P–V–T Relations of Pure Fluids - Graphical, Tabular and Mathematical representation; Generalized compressibility chart; Generalized EOS; Thermodynamic Potentials; Maxwell Relations, Thermodynamic Property Relations, Thermodynamic properties of real gases, Multicomponent mixtures, Properties of solutions, Phase Equilibrium (VLE, LLE, VLLE), Review of Thermochemistry; Chemical reaction equilibrium

**F. Text books**

**1)** Smith, J. M., Van Ness, H. C., and Abbott, M. M., Introduction to Chemical Engineering Thermodynamics, 6th ed., McGraw-Hill, 2001.

**G. Reference books**

**1)** Kyle, B.G., Chemical and Process Thermodynamics, 3rd ed., PHI, New Delhi, 1999.

**2)** Rao, Y.V.C., Chemical Engineering Thermodynamics, University Press, 1997.

**Lecture Plan:**

| LEC NO | TOPICS | Session Outcome | Mode of Delivery | Corresponding CO | Mode of assessing CO |
|---|---|---|---|---|---|
| 1 – 2 | Introduction | Brief overview of the course | Lecture | 1406.1 | Mid Term -1, End Term |
| 3 | Internal Energy, First Law of Thermodynamics, Energy balances for closed systems, Thermodynamics and state function, Equilibrium | Students will be acquainted with these basic concepts | Lecture | 1406.1 | Mid Term -1, End Term |
| 4 – 6 | Phase Rule, Reversible processes, constant V and P processes, Enthalpy, Heat capacity, Mass and energy balances for open systems | Phase rule and other key thermodynamic concepts introduced | Lecture + Tutorial | 1406.1; 1406.2 | Mid Term -1, End Term |

| | | | | | |
|---|---|---|---|---|---|
| 7 | PVT behavior of pure substances, Ideal gas | Equations of state are covered | Lecture | 1406.1; 1406.2 | Mid Term -1, End Term |
| 8 | Virial equations of state and its applications, Cubic equation of state | Equations of state are covered | Lecture | 1406.1; 1406.2 | Mid Term -1, End Term |
| 9 | Generalized correlations for gases and liquids | Equations of state are covered | Lecture | 1406.1; 1406.3 | Mid Term -1, End Term |
| 10 – 11 | Heat effects | Heat effects are introduced. | Lecture + Tutorial | 1406.1; 1406.3 | Mid Term -1, End Term |
| 12 – 14 | Second law of thermodynamics, heat engines, entropy and its applications to ideal gas, lost work and ideal work | Second law of thermodynamics is a key concept of this course | Lecture + Tutorial | 1406.3 | Mid Term -1, End Term, Assignment |
| 15 – 17 | Third law of thermodynamics | It is briefly introduced | Lecture + Tutorial | 1406.1 | Mid Term -1, End Term, Assignment |
| 18 – 19 | Property relations for homogeneous phases, residual properties, Two phase systems | Phase equilibria are key components of this course | Lecture + Tutorial | 1406.2; 1406.3 | Mid Term -2, End Term, Assignment |
| 20 | Thermodynamic diagrams, Table of Thermodynamic properties | Students taught about property tables | Lecture | 1406.2; 1406.3 | Mid Term -2, End Term |
| 21 | Generalized property correlations for gases | Students taught about property correlations | Lecture | 1406.2; 1406.3 | Mid Term -2, End Term |
| 22 | Property relationships, partial molar properties, Fugacity and fugacity coefficients, fugacity in ideal solutions | Ideal and real solutions introduced to students | Lecture | 1406.2; 1406.3 | Mid Term -2, End Term |
| 23 – 25 | Property changes of mixing, heat effects of mixing process, excess properties, activity coefficients, gas mixtures | Ideal and real solutions introduced to students | Lecture + Tutorial | 1406.2; 1406.3 | Mid Term -2, End Term, Assignment |
| 26 | Phase equilibria, nature of equilibrium, criteria of equilibrium, phase rule, Duhem's theorem, VLE | Phase equilibria are key components of this course | Lecture | 1406.4 | Mid Term -2, End Term |
| 27 – 29 | Activity coefficients, Gibbs-Duhem equation, coexistence equation, stability | Key concepts of this thermodynamics course | Lecture + Tutorial | 1406.4 | Mid Term -2, End Term |
| 30 - 33 | Systems of limited liquid-phase miscibility | Key concepts of this thermodynamics course | Lecture + Tutorial | 1406.4 | Mid Term -2, End Term |
| 34 | Chemical reaction equilibria, criteria for equilibrium, standard Gibb's free energy change, equilibrium constant, effect of temperature, relations b/w equilibrium constants and compositions, equilibrium | Various kinds of free energy concepts introduced | Lecture + Tutorial | 1406.5; 1406.6 | End Term, Assignment |

| | | | | | |
|---|---|---|---|---|---|
| | conversions for single reactions | | | | |
| 35 | Phase rule, Duhem's theorem for reacting systems | Phase rule is a key concept in thermodynamics | Lecture | 1406.5 | End Term |
| 36 | Multireaction equilibria | Concepts at the confluence of thermodynamics and chemical reactions | Lecture | 1406.5; 1406.6 | End Term, Assignment |
| 39 | Thermodynamics of flow processes, Fundamental equations, flow in pipes, maximum velocity in pipe flow | Thermodyanmics is able to explain the energetics of various mechanical processes | Lecture | 1406.6 | End Term |
| 41 - 43 | Metering and throttling process, Nozzles, compressors, ejectors, temperature measurements at high velocities | Thermodyanmics is able to explain the energetics of various mechanical processes. Practical mechanical devices discussed. | Lecture + Tutorial | 1406.6 | End Term, Assignment |

**H. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE1406.1 | Apply the basic laws of thermodynamics to calculate heat and work requirement for industrial processes | 3 | 3 | 2 | 1 | 1 | 2 | | | 3 | 1 | 2 | 1 | 3 | 2 | 2 |
| CE1406.2 | Analyze and evaluate data from PVT behavior of fluids and ideal gas systems | 3 | 2 | | | 1 | 2 | 1 | 1 | 2 | 1 | 2 | | 3 | 2 | 2 |
| CE1406.3 | Apply mass, energy and entropy balances to flow processes | 3 | 3 | 2 | 1 | 1 | 3 | | | 3 | 1 | 2 | | 3 | 3 | 2 |
| CE1406.4 | Evaluate and apply the concepts of phase equilibrium | 3 | 2 | | | | 2 | | | 2 | 1 | 2 | | 2 | 1 | 2 |
| CE1406.5 | Evaluate and apply the physical and chemical equilibrium | 3 | 2 | 1 | | | 2 | | | 1 | 1 | 2 | | 2 | 2 | 2 |
| CE1406.6 | Apply the knowledge of thermodynamics to the reacting and non-reacting processes | 3 | 3 | 2 | | 1 | 2 | | | 3 | 2 | 2 | 1 | 3 | 2 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Heat Transfer Operations | CE 1407 | 3 Credits | 3 0 0 3

Session: Jan 20 – May 20 | Faculty: Ir. Nandana Chakinala | Class: Core Course

## A. Introduction:

This course on Process Synthesis is a core course designed for the undergraduate students of Chemical Engineering. This course emphasizes on the principle concepts & methods of heat transfer in fluids and solids and their application in various heat transfer equipment in process industries. It provides insight in to the mechanism of heat transfer and design of heat transfer equipment.

## B. Course Outcomes:

At the end of the course, students will be able to

**[1407.1].** Understand the basic concepts and laws of the three modes of heat transfer.

**[1407.2].** To identify, formulate and solve engineering problems involving conduction, convection and radiation heat transfer

**[1407.3].** To identify, formulate and solve engineering problems involving boiling, condensation, evaporation and crystallization

**[1407.4].** To design heat exchangers and perform basic calculations of common heat exchangers.

**[1407.5].** To develop the problem-solving skills essential to good engineering practice of heat transfer in real world applications thus enhancing the employability

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Outcomes for B.Tech. in chemical engineering are as follows.

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**PSO.1. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**PSO.2. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes and Assignments. | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | No makeup for missed short quizzes or assignments or exam will be allowed, except in extenuating circumstances with prior permission of the instructor. The decision of the instructor in this regard will be final. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

**Introduction** – Modes of heat transfer, heat transfer equipment.

**Conduction** – Steady state conduction in one dimension, Fourier's law, Thermal conductivity, Steady state conduction of heat through composite solid, variable area and in bodies with heat sources.

**Convective heat transfer** – Overall heat transfer coefficient, heat transfer between fluids separated by plane wall, cylindrical wall, thermal contact resistance, critical insulation thickness; Forced convection – Flow over flat plate, thermal boundary layer, flow across a cylinder, Dimensionless groups in heat transfer, correlations for heat transfer coefficient for both internal and external flows; Free convection – Heat transfer correlations, combined free and forced convection.

**Radiation heat transfer** – Basic concepts, blackbody radiation, Planck's Law, Wien's displacement law, Stefan-Boltzmann Law, Kirchhoff's Law, Grey body; Radiation intensity of black body, Radiation shield, View factor, combined radiation, conduction and convection.

**Heat transfer in boiling and condensation** – Boiling phenomena and boiling curve, Mechanism of nucleate boiling, correlations for pool boiling, forced convection boiling; Condensation phenomena, condensation outside horizontal tube or tube bank, inside a horizontal tube, effect of non-condensable gases, drop wise condensation.

**Heat exchanger design** – Double pipe heat exchanger design using Kern method, Shell and tube heat exchanger design using Kern method and Bell Delaware method, Effectiveness NTU method of heat exchanger analysis. **Evaporators** – Types of evaporators and their construction and operation, Principles of evaporation and evaporators – capacity & economy, boiling point rise, heat transfer coefficient, enthalpy of solution, Evaporator selection and vapor recompression.

**Crystallization** – Crystal geometry, principles of crystallization- equilibria & yields, nucleation, crystal growth, crystallization equipment

## F. TEXT BOOKS

**T1** D.Q. Kern, "Process Heat Transfer", Mc Graw Hill, 1997.

**T2** B.K. Dutta, "Heat Transfer Principles and Application", PHI India, 2015.

**T3** J. P., Holman, "Heat Transfer", McGraw Hill, New York

## G. REFERENCE BOOKS

**R1** L. Bergman, Theodore, Adrienne S. Lavine, Incropera, Frank P, DeWitt, David P. "Introduction to Heat Transfer", 6th Edition

**R2** W.L. McCabe, J.C. Smith, P. Harriot, Unit operations of Chemical engineering, 7th edition, Mc Graw Hill.

**R3** A.S. Foust, L.A. Wenzel, C.W. Clump, L. Maus, L.B. Andersen, Principles of Unit Operations, 2nd edition, Wiley India.

**R4** J.M. Coulson and J.F. Richardson, Chemical Engineering, Volume 1, 6th edition, Elsevier

**Lecture Plan:**

| Lecture No. | TOPICS | Session Outcome | Mode of Delivery | Corresponding CO | Mode of assessing CO |
|---|---|---|---|---|---|
| 1 | Introduction to heat transfer | To understand the importance of heat transfer | Lecture | 1407.1 | |
| 2-3 | *Conduction* - Steady state conduction in one dimension, Fourier's law, Thermal conductivity | To understand the fundamental concepts and laws of heat transfer | Lecture | 1407.1 | Quiz, Mid term I, End Term |
| 4-6 | *Conduction* - Steady state conduction of heat through composite solid, variable area and in bodies with heat sources | To acquire the knowledge required in formulating and solving engineering problems related to conduction | Lecture & Tutorial | 1407.1 & 1407.2 | Quiz/Assignment, Mid term I, End Term |
| 7-8 | *Convective heat transfer* –Overall heat transfer coefficient, heat transfer between fluids separated by plane wall, cylindrical wall, thermal contact resistance, critical insulation thickness | To understand the basic principles of convective heat transfer between fluids | Lecture | 1407.1 & 1407.2 | Quiz/Assignment, Mid term I & End term |

| | | | | | |
|---|---|---|---|---|---|
| 9-11 | *Convective heat transfer* – Forced convection | To formulate and solve engineering problems related to convection | Lecture & Tutorial | 1407.2 & 1407.5 | Quiz/Assignment, Mid term I & End term |
| 12,13 | *Convective heat transfer* – Free convection | To identify, formulate and solve engineering problems related to convection | Lecture & Tutorial | 1407.2 & 1407.5 | Assignment, Mid term I & End term |
| 14-18 | *Radiation heat transfer* | To get acquainted with the basic concepts of radiative heat transfer | Lecture | 1407.1 & 1407.2 | Quiz/Assignment, Mid term II & End term |
| 19-20 | *Heat transfer in boiling* | To understand the boiling phenomena and mechanism of heat transfer involved | Lecture | 1407.3 & 1407.5 | Quiz, Mid term II & End term |
| 21-24 | *Heat transfer in condensation* | To acquaint the utility of correlations in estimating heat transfer coefficients in boiling and condensation | Lecture & Tutorial | 1407.3 & 1407.5 | Quiz, Mid term II & End term |
| 25 | *Heat exchanger design* – Double pipe heat exchanger design by Kern method | To acquire the knowledge of various design methods and perform the basic calculations of common heat exchange equipment used in industries | Lecture | 1407.1 & 1407.4 | Quiz/Assignment, Mid term II & End term |
| 26,27 | *Heat exchanger design* – Introduction to Shell and tube heat exchanger | To acquaint different types of heat exchangers used in process industries | Lecture | 1407.1 & 1407.4 | Assignment, Quiz, Mid term II & End term |
| 28-30 | *Heat exchanger design* – Shell and tube heat exchanger design using Kern Method | To perform the basic calculations of common heat exchangers used in industries | Lecture & Tutorial | 1407.4 & 1407.5 | Quiz/Assignment, Mid term II & End term |
| 30-34 | *Heat exchanger design* – Shell and tube heat exchanger design using Bell Delaware Method | To acquire the knowledge of various design methods and perform the basic calculations of common heat exchange equipment used in industries | Lecture & Tutorial | 1407.4 & 1407.5 | Quiz/Assignment, Mid term II & End term |

| | | | | | |
|---|---|---|---|---|---|
| 35-37 | *Evaporators* | To understand the mechanism of heat transfer in evaporators | Lecture | 1407.1 & 1407.3 | Assignment, Mid term II & End term |
| 38-40 | *Crystallization* | To acquaint the basic principles of crystallization and related terminology | Lecture & Tutorial | 1407.1 & 1407.3 | End term |

**H. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1407.1 | Understand the basic concepts and laws of the three modes of heat transfer | 3 | 3 | | 1 | | 2 | 2 | | | | 2 | | 2 | | |
| CE 1407.2 | To identify, formulate and solve engineering problems involving conduction, convection and radiation heat transfer | 2 | 3 | 1 | | | 1 | | | | | | | 2 | | |
| CE 1407.3 | To identify, formulate and solve engineering problems involving boiling, condensation, evaporation and crystallization | 2 | 3 | 1 | | | 1 | | | | | | 3 | 2 | 1 | |
| CE 1407.4 | To design heat exchangers and perform basic calculations of common heat exchangers | | 2 | | | | 1 | 2 | | | | | | 3 | 1 | |
| CE 1407.5 | To develop the problem-solving skills essential to good engineering practice of heat transfer in real world applications | | 2 | | | | 1 | 2 | | | | | | 3 | 1 | |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering
Department of Chemical Engineering
Course Hand-out
Numerical Methods in Chemical Engineering | CE 1408 | 4 Credits | 3 1 0 4
Session: Jan 20 – May 20 | Faculty: Dr. Harsh Pandey | Class: B. Tech. (Chemical) IV Semester

**A. Introduction:** In chemical engineering, problems related to momentum, heat and mass transfer, chemical reaction engineering, thermodynamics, modeling and simulation, etc. involve linear / nonlinear algebraic equations, ordinary differential equations or partial differential equations. Numerical methods give the solution of applied problems when ordinary analytical methods fail. This course is designed to give an overview of numerical methods for solving a variety of problems encountered by a process engineer. MATLAB will be used as the working environment to solve the problems using step-wise, repeated and iterative solution methods, which would otherwise be tedious or unsolvable by hand-calculations. Since the focus is on the techniques themselves, rather than specific applications, the contents should be relevant to varied fields such as engineering, management, economics, etc.

**B. Course Outcomes:** At the end of the course, students will be able to:

| | |
|---|---|
| **[CO.1]** | Solve the linear and non-linear algebraic equations using direct and iterative numerical techniques |
| **[CO.2]** | Approximate the function using appropriate numerical method |
| **[CO.3]** | Evaluate the integral using numerical methods |
| **[CO.4]** | Solve the ordinary differential equations by an appropriate numerical method |
| **[CO.5]** | Solve the partial differential equations by an appropriate numerical method |
| **[CO.6]** | Apply the numerical techniques to solve variety of chemical engineering problems, leading to skill enhancement of students |

**C. Program Outcomes and Program Specific Outcomes**

| | |
|---|---|
| **[PO.1].** | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems |
| **[PO.2].** | **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences |
| **[PO.3].** | **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations |
| **[PO.4].** | **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| **[PO.5].** | **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations |

**[PO.6].** **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

**[PO.7].** **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8].** **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9].** **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10].** **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11].** **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12].** **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

**[PSO.1].** Concept to Commissioning: The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant.

**[PSO.2].** Process Intensification: graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3].** Specialization: Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | Quizzes and Home/Class Assignments/Active Learning Assignments (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. If a student miss a lecture, he himself has to study the topics that have been covered during that particular lecture. The student may contact the course coordinator for clarification of his/her doubts, if any. | |
| Make up Assignments (Formative) | Students who miss a class will not be provided with any sort of makeup assignment or make up quiz. If you miss a lecture, you yourself have to study the topics that were covered during that particular lecture. You may contact the course coordinator for clarification of doubts, if any. | |

| | |
|---|---|
| Active Learning Assignments (Formative) | Students are required to develop MATLAB codes for the Numerical Methods covered in lectures. They can develop their own programs to solve a variety of problems incorporating linear/ non-linear algebraic equations, curve fitting, ordinary and partial differential equations. |

## E. Syllabus

Finite Differences, Interpolation: Newton's, Stirling's interpolation formulae, Lagrange's Interpolation for unequal intervals. Numerical Integration: Simpson's and Trapezoidal Rule, Solution of Linear Algebraic Equations: Gauss's Elimination method, Gauss's Siedel Method, LU Decomposition Method, Eigen Values and Eigen Vectors: Introduction, Power method, Solutions of Non-Linear Equations, Regula Falsi Method, Newton-Raphson technique, Secant Method, Function Approximation: least square method of curve fitting, Numerical Solutions of Ordinary Differential Equations: Runga-Kutta Method, Pridictor-corrector Methods, Boundary value problems, Shooting Method, Finite difference Technique, Partial Differential Equations, Types of PDE, Finite difference technique(Method of lines), Numerical Solution of Heat, Wave and Laplace Equations.

## F. Text Books


1. Gupta, S. K., "Numerical Methods for Engineers," New Age International Ltd., New Delhi, 1995.


## G. Reference Books


1. Srimantha Pal, "Numerical Methods", Oxford University Press, 2012.
2. Saumeyen Guha, Rajesh Srivastava, "Numerical Methods for Engineering and Science," Oxford University Press, 2012.
3. Carnahan, B., Luther, H. A., and Wilkes, J.O., "Applied Numerical Methods", John Wiley, New York, 1969.
4. Constantinides, A., and Mostoufi, N., "Numerical Methods for Chemical Engineers with MATLAB Applications," Prentice Hall, 1999.
5. Hanna, O.T. and Sandall,O.C., "Computational Methods in Chemical Engineering," Prentice-Hall, 1995.
6. Sastry, S. S., "Introductory Methods of Numerical Analysis", PHI, 2012.


## H. Lecture Plan:

| Class Number | Topics | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introduction to Numerical Methods | To introduce numerical methods to the students | Lecture, Interaction | CE1408.1 | NA |
| 2 | Linear algebraic equations | To acquaint students to the basics of linear algebraic equations | Interaction, Discussion | CE1408.1 | Assignment |
| 3, 4 | Gauss Elimination | This key concept for solving equations is introduced | Interaction, Discussion | CE1408.1 | Assignment |
| 5,6 | LU Decomposition | This key concept for solving equations is introduced | Interaction, Discussion | CE1408.1 | Assignment |
| 7,8 | Gauss-Jordan Elimination | This key concept for solving equations is introduced | Interaction, Discussion | CE1408.1 | Assignment |
| 9,10 | Gauss-Siedel Elimination | This key concept for solving equations is introduced | Interaction, Discussion | CE1408.1 | Assignment |
| 11,12 | Eigen Values and Eigen Vectors: Introduction, Power Method | The significance of these in linear algebra is discussed | Interaction, Discussion | CE1408.1 | Assignment |
| 13 | Pre-Sessional Review | Review of Syllabus Covered | Discussion | CE1408.1 | NA |
| FIRST SESSIONAL EXAM | | | | | |
| 14 | Review of First Sessional Exam | Review | Interaction, Discussion | CE1408.1 | NA |

| | | | | | |
|---|---|---|---|---|---|
| 15, 16 | Non-linear algebraic equations, Introduction, Regula Falsi Method | Introducing non-linear equations to the students | Interaction, Discussion | CE1408.1 | Assign ment |
| 17,18 | Newton-Raphson technique | This key technique for solving non-linear equations is introduced | Discussion, Chalkboard problem solving | CE1408.1 | Assign ment, Quiz |
| 19 | Secant Method | This key technique for solving non-linear equations is introduced | Discussion, Chalkboard problem solving | CE1408.1 | Assign ment |
| 20 | Function Evaluation, least square method of curve fitting | Curve fitting is a key concept in this course, and is introduced | Discussion, Chalkboard problem solving | CE1408.2, CE1408.3 | Assign ment |
| 21,22 | Newton's, Stirling's interpolation formulae | Curve fitting and interpolation is a key concept in this course, and is introduced | Discussion, Chalkboard problem solving | CE1408.2, CE1408.3 | Assign ment |
| 23,24 | Lagrange's Interpolation for unequal intervals | Curve fitting and interpolation is a key concept in this course, and is introduced | Discussion, Chalkboard problem solving | CE1408.2, CE1408.3 | Assign ment |
| 25,26 | Numerical Solutions of Ordinary Differential Equations, Predictor-corrector Methods | ODEs form a key backbone of this course, and are introduced here | Discussion, Chalkboard problem solving | CE1408.4 | Assign ment |
| 27,28 | Runge-Kutta Method | RK method is a key concept in solving ODEs and PDEs numerically, and is covered | Discussion, Chalkboard problem solving | CE1408.4 | Assign ment |
| 29 | Pre-Sessional Review | Review | Interaction, Discussion | CE1408.1, CE1408.2, CE1408.3, CE1408.4 | NA |
| SECOND SESSIONAL EXAM | | | | | |
| 30 | Review of Second Sessional Exam | Review | Interaction, Discussion | CE1408.1, CE1408.2, CE1408.3, CE1408.4 | NA |
| 31,32 | Boundary value problems, Finite difference Technique | Is a key concept in solving ODEs numerically, and is covered | Interaction, Discussion | CE1408.4 | Assign ment |
| 33, 34 | Shooting Method | Is a key concept in solving ODEs numerically, and is covered | Interaction, Discussion | CE1408.4 | Assign ment |
| 35,36 | Partial Differential Equations, Types of PDE | PDEs are introduced to the students | Interaction, Discussion | CE1408.5 | Assign ment |
| 37,38 | Finite difference technique (Method of lines) | Is a key concept in solving PDEs numerically, and is covered | Discussion, Chalkboard problem solving | CE1408.5 | Assign ment |
| 39, 41 | Numerical Solution of Heat, Wave and Laplace Equations | Extremely useful for Chemical Engineering students, are introduced and solved here | Discussion, Chalkboard problem solving | CE1408.4, CE1408.5, CE1408.6 | Assign ment |
| 42 | Pre-End Term Exam Review | Review | Interaction, Discussion | CE1408.1, CE1408.2, CE1408.3, CE1408.4, | NA |

| | | | | | |
|---|---|---|---|---|---|
| | | | | CE1408.5, CE1408.6 | |
| END TERM EXAM | | | | | |

## I. Course Articulation Matrix: (Mapping of COs with POs & PSOs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE1408.1 | Solve the linear and non-linear algebraic equations using direct and iterative numerical techniques | 3 | 2 | | | 2 | 1 | 3 | | 2 | 2 | 2 | | 2 | 1 | 1 |
| CE1408.2 | Approximate the function using appropriate numerical method | 3 | 2 | | | 2 | 1 | 2 | | 2 | 2 | 2 | | 1 | 1 | |
| CE1408.3 | Evaluate the integral using numerical methods | 3 | 2 | | | 2 | 1 | | | 2 | 2 | 2 | | 1 | 1 | 1 |
| CE1408.4 | Solve the ordinary differential equations by an appropriate numerical method | 3 | 2 | | | 2 | 1 | 3 | | 2 | 2 | 2 | | 2 | 2 | 2 |
| CE1408.5 | Solve the partial differential equations by an appropriate numerical method | 3 | 2 | | | 2 | 1 | 2 | | 2 | 2 | 2 | | 2 | 2 | 2 |
| CE1408.6 | Apply the numerical techniques to solve variety of chemical engineering problems, leading to skill enhancement of students | 3 | 3 | 1 | | | 2 | 2 | 1 | 2 | 2 | 3 | 1 | 3 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

**MANIPAL UNIVERSITY JAIPUR**

School of Basic Sciences

Department of Chemistry
Course Hand-out

Physical and Analytical Chemistry | CY1421| 4 Credits | 3104

Session: Jan 20 – May 20 | Faculty: Dr. Praveen Kumar Surolia | Class: Chemical Engineering 4th Semester B. Tech

**A. Introduction:** This course is offered by Dept. of Chemistry for 2nd year chemical engineering B. Tech. students. The objective of the course is to acquaint the students with the basic concepts of physical and analytical chemistry. The student with the knowledge of the topics covered such as surface chemistry, colloids, phase rules, photochemistry and various analytical techniques will understand about various physical systems, alloys, surface phenomenon and characterization of reaction products at molecular level, relevant in the industry/engineering field.

**B. Course Outcomes:** At the end of the course, students will be able to

**[CY1421.1].** Discuss surface chemistry, colligative properties, colloids and apply concepts of adsorption and catalysis.

**[CY1421.2].** Explain the basics of phase rule and recognize single and two components systems.

**[CY1421.3].** Elaborate photochemical and photophysical processes to explain photochemical energy conversion and other related issues.

**[CY1421.4].** Discuss instrumental analysis techniques and skills in advanced methods of separation and analysis.

**[CY1421.5].** Illustrate spectroscopic and electrochemical techniques for skill enhancement for the successful chemical analysis.

**C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

[PO.1]. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.3]. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

[PO.4]. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6]. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12]. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change Understand the basic principles of chemistry and to explain them clearly.

[PSO.1]. Concept to Commissioning: The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concers.

[PSO.2]. Process Intensification: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments

[PSO.3]. Specialization: Students will be specialized in the areas of petroleum, energy and environment related fields

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 20 |
| | Sessional Exam II (Close Book) | 20 |
| | Quiz tests and presentations (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Close Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity will help the | |

**E. SYLLABUS**

Surface Chemistry: Ideal and non- ideal solutions, Henry's & Raoult's law, Colligative properties, Colloids, Adsorption and catalysis.

Phase Diagram And Phase Transformations: Phase rule, Single component systems, Binary Phase Diagrams, Lever rule, Typical Phase diagrams for Magnesia-Alumina, Copper-Zinc, Iron-carbon system.

Photochemistry: Jablonski diagram, Laws of photochemistry and quantum yield, Some examples of photochemical reactions, Applications of photochemistry.

Instrumental Analysis: Gas chromatography and High pressure liquid chromatography, Ion exchange separation, Electro analytical techniques, Spectral Techniques and Structural elucidation: UV- Vis, IR, NMR and Mass, Fuel analysis, Food analysis, Drug analysis.

**F. TEXT BOOKS**

*A book or a set of books which covers 60% or more of the syllabus can be written under this category.* (Not more than 3)

T.1. Atkins, P., and de Paula, J., Atkin's Physical Chemistry, 9th ed., W. H. Freeman & Co., 2009

T.2. Puri, B.R., Sharma, L.R., and Pathania, M. S., Principles of Physical Chemistry, S.N. Chand and Co. Jalandhar, 31st ed., 1990.

T.3. Adamson, A.W., Physical Chemistry of Surfaces, Inter science Publishers Inc. New York 1997.

**G. REFERENCE BOOKS**

R.1. Harvey, D., Modern Analytical Chemistry, McGraw Hill, 2000.

R.2. Nelson, W.L., Petroleum Refinery Engineering, Mc Graw-Hill Book Company, 1969.

R.3. Speight, J. G., Fuel Science &Technology Hand Book, Marcel Dekker, New York 1990.

**H. Lecture Plan:**

| Lecture No. | Topics | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1. | **Surface Chemistry:** Solubility, Henry's law, Different concentration terms | Understanding the concept of solubility and solution | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 2. | **Surface Chemistry:** Numerical based on Solubility, Henry's law, Different concentration terms | NA | Interactive/Self study | CY1421.1 | Mid Term I<br>End Term |
| 3. | **Surface Chemistry:** Vapour pressure, Raoult's law and its modification, Relative lowering of vapour pressure | Interpretation of vapour pressure and colligative properties | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 4. | **Surface Chemistry:** Numerical based on Vapour pressure, Raoult's law and its modification, Relative lowering of vapour pressure | NA | Interactive/Self study | CY1421.1 | Mid Term I<br>End Term |
| 5. | **Surface Chemistry:** Ideal solutions and non-ideal solutions, Maximum and minimum boiling solutions | Understanding the concept of solutions and respective boiling point | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 6. | **Surface Chemistry:** Numerical | NA | Interactive/Self study | CY1421.1 | Mid Term I<br>End Term |
| 7. | **Surface Chemistry:** Colligative Properties, Vapour pressure, Boiling point | Interpretation of vapour pressure and colligative properties | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 8. | **Surface Chemistry:** Numerical based on Colligative Properties: Vapour pressure, Boiling point | NA | Interactive/Self study | CY1421.1 | Mid Term I<br>End Term |
| 9. | **Surface Chemistry:** Freezing point, Osmotic pressure | Interpretation of colligative properties | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 10. | **Surface Chemistry:** Numerical based on Colligative Properties: Freezing point, Osmotic pressure | NA | Interactive/Self study | CY1421.1 | Mid Term I<br>End Term |
| 11. | **Surface Chemistry:** Adsorption, Adsorption versus absorption, Types of adsorption: physisorption and chemisorption, Desorption | Understanding the concept of adsorption | Lecture | CY1421.1 | Mid Term I<br>End Term |

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|---|---|---|---|---|---|
| 12. | **Surface Chemistry:** Adsorption isotherms: Freundlich and Langmuir, Adsorption isobar | Construct the various adsorption isotherms | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 13. | **Surface Chemistry:** Numerical problems based on adsorption | NA | Interactive/Self study | CY1421.1 | Mid Term I<br>End Term |
| 14. | **Surface Chemistry:** Colloids, Dispersed Systems and their classification, Size and shape of colloids | Discuss and understand colloidal systems | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 15. | **Surface Chemistry:** Purification of colloidal solutions, Applications of colloidal solutions, types of colloids: lyophobic and lyophilic | Elaborate the applications of colloidal systems | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 16. | **Surface Chemistry:** Optical Properties, Kinetic Properties, Electric Properties | Recall the properties of colloidal systems | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 17. | **Surface Chemistry:** Stability of colloids, Coagulation, Hardy Schulze law, Protective action of lyophilic colloids, Applications of colloids | Discuss the protective action and applications of colloids | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 18. | **Surface Chemistry:** Catalytic activity at surfaces, Adsorption and Catalysis, The Langmuir-Hishelwood (LH) mechanism, The Eley-Rideal (ER) mechanism | Elaborate the catalytic activity at surface | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 19. | **Surface Chemistry:** Unimolecular Reactions, Bimolecular Reactions | Recall the reactions at surfaces | Lecture | CY1421.1 | Mid Term I<br>End Term |
| 20. | **Phase Diagram And Phase Transformations:** Phase rule, Introduction, Definition and examples of phase, component and degrees of freedom | Construct phase diagrams with examples | Lecture | CY1421.2 | Mid Term II<br>End Term |
| 21. | **Phase Diagram And Phase Transformations:** One component system, water system, Carbon dioxide System, Sulphur System | Understand and construct phase diagrams with examples | Lecture | CY1421.2 | Mid Term II<br>End Term |
| 22. | **Phase Diagram And Phase Transformations:** Problems based on single component systems | Explain one component system | Lecture | CY1421.2 | Mid Term II<br>End Term |
| 23. | **Phase Diagram And Phase Transformations:** Binary phase diagrams, Condensed phase rule, Lever rule, Eutectic, Eutectoid, & Peritectic | Explain two component system | Lecture | CY1421.2 | Mid Term II<br>End Term |
| 24. | **Phase Diagram And Phase Transformations:** Numerical based on Lever rule | NA | Interactive/Self study | CY1421.2 | Mid Term II<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 25. | **Phase Diagram And Phase Transformations:** Iron-Carbon system | Elaborate Iron-Carbon phase system | Lecture | CY1421.2 | Mid Term II<br>End Term |
| 26. | **Phase Diagram And Phase Transformations:** Copper-Zinc system, Magnesia-Alumina system | Elaborate Cu-Zn, $MgO_2$-$Al_2O_3$ phase system | Lecture | CY1421.2 | Mid Term II<br>End Term |
| 27. | **Photochemistry:** Laws Governing Absorption Of Light, Lambert's Law, Beer's Law | Recall the basics of photochemistry | Lecture | CY1421.3 | Mid Term II<br>End Term |
| 28. | **Photochemistry:** Laws Governing Photochemistry, Grotthus-Draper Law, Stark-Einstein's Law ( Second Law of Photochemistry), Interpretation Of Einstein's Law, Quantum Yield | Recall the laws of photochemistry | Lecture | CY1421.3 | Mid Term II<br>End Term |
| 29. | **Photochemistry:** Luminescence, Chemiluminecence, Fluorescence, Phosphorescence, Jablonski Diagram | Understanding of Jablonski Diagram | Lecture | CY1421.3 | Mid Term II<br>End Term |
| 30. | **Photochemistry:** Fluorescence process: Population of energy levels, Stokes shift, Invariance of emission wavelength with excitation wavelength, Mirror image rule, Internal conversion vs. fluorescence emission | Explain radiative and non-radiative processes | Lecture | CY1421.3 | Mid Term II<br>End Term |
| 31. | **Photochemistry:** Photosensitization, The Born-Oppenheimer Approximation, Franck-Condon Principle | Explain the Franck-Condon Principle | Lecture | CY1421.3 | Mid Term II<br>End Term |
| 32. | **Photochemistry:** Examples of photochemical reactions, Isomerization, Paternò-Büchi Reaction, Norrish reaction | Recall the organic photochemical reactions | Lecture | CY1421.3 | Mid Term II<br>End Term |
| 33. | **Photochemistry:** $H_2$-$Cl_2$ reaction, $H_2$-$Br_2$ reaction | Recall the photochemical chain reactions | Lecture | CY1421.3 | Mid Term II<br>End Term |
| 34. | **Photochemistry:** Quenching of Fluorescence, STERN-VOLMER EQUATION | Understand the fundaments of quenching | Lecture | CY1421.3 | Mid Term II<br>End Term |
| 35. | **Instrumental Analysis:** Introduction to Chromatography, Types of Chromatography, Number of theoretical plates, Van Deemter equation | Recall the basics of chromatography | Lecture | CY1421.4 | End Term |
| 36. | **Instrumental Analysis:** Gas chromatography | Explain gas chromatography | Lecture | CY1421.4 | End Term |
| 37. | **Instrumental Analysis:** High performance liquid chromatography | Explain HPLC | Lecture | CY1421.4 | End Term |
| 38. | **Instrumental Analysis:** Ion exchange chromatography | Explain ion exchange chromatography | Lecture | CY1421.4 | End Term |

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|---|---|---|---|---|---|
| 39. | **Instrumental Analysis:** Introduction to spectroscopy, UV and Visible Spectroscopy, chromophores and auxochromes, Electronic transitions, Orbital Spin States | Recall basics of UV-Vis spectroscopy | Lecture | CY1421.5 | End Term |
| 40. | **Instrumental Analysis:** UV and Visible Spectroscopy, Selection Rules of electronic transition, Spectral nomenclature of shifts (Bathochromic shift, Hysochromic shift, Hyperchromism, Hypochromism) | Elaborate principle and application of UV-Vis spectroscopy | Lecture | CY1421.5 | End Term |
| 41 | **Instrumental Analysis:** UV/VIS of Aromatic compound, unsaturated ketones, Polyenes, and Unsaturated Carbonyl groups, Woodward-Fieser rule-examples and applications | Elaborate principle and application of UV-Vis spectroscopy | Lecture | CY1421.5 | End Term |
| 42. | **Instrumental Analysis:** Charge-Transfer Absorption, d → d electronic transitions | Understand charge transfer absorption | Lecture | CY1421.5 | End Term |
| 43. | **Instrumental Analysis:** Infrared Spectroscopy, Introduction, Vibrational Modes, Vibrational Frequencies of Bonds, Hooke's Law | Recall basics of IR spectroscopy | Lecture | CY1421.5 | End Term |
| 44. | **Instrumental Analysis:** The IR Spectrum – The detection of different bonds, Examples | Elaborate principle and application of IR spectroscopy | Lecture | CY1421.5 | End Term |
| 45. | **Instrumental Analysis:** Mass Spectroscopy, Introduction, General Schematic of mass spectrophotometer | Recall basics of mass spectroscopy | Lecture | CY1421.5 | End Term |
| 46. | **Instrumental Analysis:** Fragmentation Processes, The Even-Even Rule, The Nitrogen Rule, Rule of Thirteen, Metastable peaks, examples | Elaborate principle and application of mass spectroscopy | Lecture | CY1421.5 | End Term |
| 47. | **Instrumental Analysis:** Nuclear Magnetic Resonance Spectroscopy, Introduction, Theory of NMR, Shielding and De-shielding of protons | Recall basics of NMR spectroscopy | Lecture | CY1421.5 | End Term |
| 48. | **Instrumental Analysis:** Chemical Shift, Spin-Spin splitting, The N + 1 Rule, Coupling constant, examples | Elaborate principle and application of NMR spectroscopy | Lecture | CY1421.5 | End Term |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CY 1421.1 | Discuss surface chemistry, colligative properties, colloids and apply concepts of adsorption and catalysis | 2 | | | | | | 3 | | | 2 | | 2 | 3 | 1 | 2 |
| CY 1421.2 | Explain the basics of phase rule and recognize single and two components systems | | | 2 | | | | | 2 | | | | 3 | 1 | 0 | 3 |
| CY 1421.3 | Elaborate photochemical and photophysical processes to explain photochemical energy conversion and other related issues | 2 | | | | 3 | | | | | 3 | | 2 | 2 | 1 | 3 |
| CY 1421.4 | Discuss instrumental analysis techniques and skills in advanced methods of separation and analysis | | | | | | | | 2 | | | | 2 | 2 | 1 | 1 |
| CY 1421.5 | Illustrate spectroscopic and electrochemical techniques for the successful chemical analysis | | 2 | | | 2 | | | 2 | | | | 3 | | | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Process Modelling and Simulation| CE 1505/04 | 3/4 Credits | 3 0 0 3/3 1 0 4

Session: July 19 – Dec 19 | Faculty: Dr Gaurav Kataria| Class: B.Tech III Year

**A. Introduction:** This course is offered by Dept. of Chemical Engineering as a core course. This course focuses on the modelling and simulation of processes involved in chemical engineering operations. In this unit, the students will learn the fundamentals of process synthesis and design using mathematical modelling tools. By the end of this course, the students will have a clear understanding required for analysis of process engineering solutions of real world problems.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1505.1]** Understand the basic principles of process modelling and simulation

**[1505.2]** Carry out the analysis of lumped and distributed models used in process intensive industries

**[1505.3]** Perform the validation, parametric estimation and optimization of a process model

**[1505.4]** Develop the skills to generate process flowsheet using different unit operations in a process simulator

**[1505.5]** Carry out the simulation for generation of material and energy balances for overall system

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**PO.1** **Engineering Knowledge:** A thorough knowledge of the basic science, engineering and mathematics and apply that to the underline practice of Chemical Engineering.

**PO.2** **Problem Analysis:** Ability to apply these basic principles to solve real world problems in a broad range of career paths.

**PO.3** **Project management and finance:** The skills of making smart decisions on process feasibility based in technical and economic evaluation.

**PO.4** **Ethics**: The ability to appreciate the social, ethical, cultural, environmental and safety issues related to chemical engineering profession.

**PO.5** **Conduct investigations of complex problems**: The ability to develop experimental procedure/protocol to test hypothesis and analysis meaningful interpretation of the generated data.

**PO.6** **Environment and sustainability**: The skill to generate sustainable engineering solutions to societal and industrial problems.

**PO.7** **Modern tool usage**: Proficiency to use computational tools for problem solving.

**PO.8** **Communication**: ability to communicate effectively (technical and non-technical context) in written and oral form.

**PO.9** **Design/development of solutions**: Skills to work effectively and professionally in multi-disciplinary groups to solve complex chemical engineering problems.

**PO.10** **Individual and team work**: The ability to work effectively and professionally on projects both independently and as a part of a group/team.

**PO.11** **Life-long learning**: The ability to be self-learners and lifelong learners.

**PO.12** **The engineer and society**: The motivation to develop and lead entrepreneurial projects for societal benefit.

Degree Specific Outcomes for chemical engineering are as follows:

**PSO.1** **Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant.

**PSO.2** **Process Intensification:** Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3** **Specialization:** students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes, Assignments, Projects | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | No makeup assignments will be given. | |
| Projects | Each group of 2-3 students will submit a project on a topic relevant to the industrial application of process modelling and simulation. The details of this component will be discussed during the lectures. | |

## E. SYLLABUS

**Pre-requisites:** CE1401 and CE1404

Fundamentals and industrial applications of process modeling and simulation, Macroscopic mass, energy and momentum balances, integration of fluid thermodynamics, chemical equilibrium, reaction kinetics and feed/ product property estimation in mathematical models. Steady state lumped systems, modeling of chemical process equipment (reactors, distillation, absorption, extraction columns, evaporators, and heat exchangers). Modelling and simulation of complex industrial systems in petroleum, petrochemicals, polymer, basic chemical industries; Commercial steady state and dynamic simulators; Simulation of process flow sheets.

## F. BOOKS


- Luyben, W. L., *Process Modeling, Simulation and Control for Chemical Engineers*, McGraw Hill, 1989.
- Ramirez, W.F., *Computational Methods for Process Simulation*, 2nd ed., Butterworth-Heinemann, 1997.
- Ingham, J., Dunn, I. J., Heinzle, E., Prenosil, J.E., Snape, J.B., *Chemical Engineering Dynamics: An Introduction to Modelling and Computer Simulation*, 3rd ed., Wiley-VCH Verlag GmbH & Co. KGaA, 2007.
- Holland, C. D., *Fundamentals and Modeling of Separation Processes*, Prentice Hall, 1975.
- Himmelblau, D. M., & Bischoff, K. B., *Process analysis and simulation: Deterministic systems*, John Wiley, New York, 1968.

**G. Lecture Plan:**

| LEC NO | TOPICS | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Modelling Overview and Industrial Applications of Process Modelling | Understanding the basic need of modelling and simulation in chemical engineering. | Lecture | CE1505.1 | Mid Term I<br>End Term |
| 2 | Modelling Process | Understanding the basic 7 step modeling process. | Lecture | CE1505.1 | Mid Term I<br>End Term |
| 3 | Process Model Characteristics and Introduction to Matlab | Understanding the use of MATLAB in the course. | Lecture | CE1505.4 | Mid Term I<br>End Term |
| 4 | System Definition; White, Black and Grey Box Models | Understanding the difference between white, black and grey box models. | Lecture | CE1505.1 | Mid Term I<br>End Term |
| 5,6 | Systematic Modelling Procedure | Applying 7 step modelling process in chemical engineering applications. | Lecture | CE1505.1 | Mid Term I<br>End Term |
| 7 | Introduction to Matlab Files | Understanding the use of MATLAB in the course. | Lecture | CE1505.4 | Mid Term I<br>End Term |
| 8 | Fundamental Concepts | Understanding the basic concepts used in the modeling of chemical engineering equipment's. | Lecture | CE1505.1 | Mid Term I<br>End Term |
| 9,10,11 | Conservation Equations | Understanding the basics of using mass, material and energy balance. | Lecture | CE1505.5 | Mid Term I<br>End Term |
| 12,13 | Constitutive Relations | Understanding the constitutive relations used in chemical engineering. | Lecture | CE1505.5 | Mid Term I<br>End Term |
| 14 | Matlab Applications | Apply MATLAB in the chemical engineering applications. | Lecture | CE1505.1/2 | Mid Term I<br>End Term |
| 15 | Introduction to Lumped Models | Understanding the concept of having variation of variable with time. | Lecture | CE1505.1/2 | Mid Term I<br>End Term |
| 16 | Solution of Ordinary Differential Equations | Use of Runge Kutta and other ODE solvers. | Lecture | CE1505.1/2 | Mid Term I<br>End Term |
| **MID TERM I** | | | | | |
| 17 | Matlab Applications | Use of Runge Kutta and other ODE solvers in MATLAB. | Lecture | CE1505.1/2 | Mid Term II<br>End Term |
| 18 | Introduction to Distributed Models | Understanding the concept of having variation of variable with time and space. | Lecture | CE1505.1/2 | Mid Term II<br>End Term |
| 19 | Initial and Boundary Conditions | Understanding the concept of using initial and boundary conditions. | Lecture | CE1505.1/2 | Mid Term II<br>End Term |
| 20 | Real Time Applications | Use the concepts for real applications of chemical engineering. | Lecture | CE1505.1/2 | Mid Term II<br>End Term |
| 21 | Partial Differential Equations Solving Methods | Understanding the concept of solving PDEs. | Lecture | CE1505.1/2 | Mid Term II<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 22 | Finite Difference Approximation and Boundary Conditions Handling | Understanding the concept of solving PDEs. | Lecture | CE1505.1/2 | Mid Term II<br>End Term |
| 23 | Matlab Applications | Apply MATLAB to solve PDEs. | Lecture | CE1505.4 | Mid Term II<br>End Term |
| 24,25 | Model Validation and Verification, Model Calibration | Applying the simulation to validate and verify the model. | Lecture | CE1505.1/2 | Mid Term II<br>End Term |
| 26 | Model Optimization and Parameter Estimation | Applying the simulation to validate and verify the model. | Lecture | CE1505.1/2 | Mid Term II<br>End Term |
| 27 | Matlab Applications | Apply MATLAB in the chemical engineering applications | Lecture | CE1505.4 | Mid Term II<br>End Term |
| 28,29 | Process Synthesis and Design | Applying the simulation to provide the design of the equipment. | Lecture | CE1505.4 | Mid Term II<br>End Term |
| **MID TERM II** | | | | | |
| 30 | Aspen Hysys Introduction | Understanding the use of ASPEN in the course. | Lecture | CE1505.4 | End Term |
| 31 | Convergence Methods | Understand the convergence and divergence of the solution. | Lecture | CE1505.1 | End Term |
| 32 | Sequential Modular vs Equation Oriented Simulation | Understand the convergence and divergence of the solution. | Lecture | CE1505.1 | End Term |
| 33 | Aspen Hysys Unit Models | Apply ASPEN in the chemical engineering applications | Lecture | CE1505.4 | End Term |
| 34 | Reactor Design | Use the balances to design a reactor. | Lecture | CE1505.3/4/5 | End Term |
| 35 | Thermodynamic Package Selection | Understand the uses of thermodynamic packages in the software's. | Lecture | CE1505.1 | End Term |
| 36 | Package Selection Recommendations | Understand the uses of thermodynamic packages in the software's. | Lecture | CE1505.1 | End Term |
| 38 | Types of Heat Exchanger | Use the balances to design a heat exchanger. | Lecture | CE1505.3/4/5 | End Term |
| 39 | Heat Exchanger Balance | Use the balances to design a reactor. | Lecture | CE1505.3/4/5 | End Term |
| 40,41 | Heat Exchanger Design | Use the balances to design a reactor. | Lecture | CE1505.3/4/5 | End Term |
| 42 | Degree of Freedom Analysis, Control Synthesis using Industry Example | Understand the concept of DoF to assume the parameters constant for solving the model. | Lecture | CE1505.3/4/5 | End Term |
| **END TERM** | | | | | |

**H. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1505.1 | Understand the basic principles of process modelling and simulation | 2 | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 3 | 0 | 0 | 1 | 2 | 0 | 0 |
| CE 1505.2 | Carry out the analysis of lumped and distributed models used in process intensive industries | 3 | 3 | 0 | 0 | 2 | 1 | 3 | 0 | 3 | 0 | 0 | 0 | 2 | 2 | 1 |
| CE 1505.3 | Perform the validation, parametric estimation and optimization of a process model | 2 | 3 | 0 | 1 | 2 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 1 | 2 | 1 |
| CE 1505.4 | Develop the skills to generate process flowsheet using different unit operations in a process simulator | 3 | 3 | 0 | 0 | 2 | 0 | 3 | 0 | 3 | 2 | 0 | 0 | 3 | 2 | 1 |
| CE 1505.5 | Carry out the simulation for generation of material and energy balances for overall system | 3 | 3 | 0 | 0 | 2 | 0 | 3 | 0 | 3 | 1 | 0 | 0 | 3 | 2 | 1 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

**MANIPAL UNIVERSITY JAIPUR**
School of Civil and Chemical Engineering
Department of Chemical Engineering
Course Handout
Mass Transfer I | CE1506 | 3 Credits | 3 0 0 3
Session: Jul'19 – Dec'19 | Faculty: Dr. Manisha Sharma | Class: B. Tech. (Chemical)
V Semester

## A. INTRODUCTION

This course is offered by Department of Chemical Engineering as a core course. The course focuses on the fundamentals of molecular diffusion, convective mass transfer, and interphase mass transfer. It deals with the design of various mass transfer equipment related to absorption, stripping, adsorption, and humidification.

## B. COURSE OUTCOMES

At the end of the course, students will be able to:

**[CE1506.1]** Understand the basics of diffusional mass transfer

**[CE1506.2]** Understand the concepts of interphase mass transfer and mass transfer coefficients

**[CE1506.3]** Understand the mechanism of various mass transfer operations such as absorption, stripping, adsorption, and humidification

**[CE1506.4]** Develop skills to perform design calculations involved in various mass transfer operations

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**PSO.1. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**PSO.2. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. ASSESSMENT PLAN

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | Quizzes and Home Assignments / Class Assignments (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Assignments (Formative) | Assignments are an integral part of the course. Home assignments / Class assignments will be provided from time to time. No late submissions will be entertained. It is expected that the students will work on the assignments independently. If any assignment is found copied from any source, marks will be deducted for the same. | |
| Make up Assignments | Students who miss a class will not be provided with any sort of makeup assignment or make up quiz. If you miss a lecture, you yourself have to study the topics that were covered during that particular lecture(s). You may contact the course coordinator for clarification of doubts, if any. | |

## E. SYLLABUS

Introduction to mass transfer operations. Theory of interphase mass transfer, estimation of mass transfer coefficient, individual and overall mass transfer coefficients for gas-liquid and liquid-liquid operations. Gas Absorption, graphical calculation of number of theoretical stages for absorption and stripping column. Adsorption, adsorption isotherm, batch and continuous stage adsorption, design of adsorption column, and adsorption equipment. Vapor gas mixtures, terminology, Psychometric chart, Water cooling operations, Gas-Liquid contact operations, adiabatic operations, Types of equipment, Design calculations, Cooling towers, design of cooling towers, Recirculating Liquid-gas humidification cooling.

## F. TEXT BOOKS

T1. Treybal, R. E., Mass Transfer Operations, 3rd ed., McGraw Hill, 2012.

T2. Seader, J. D. and Henley, E. J., Separation Process Principles, 2nd ed., Wiley, 2010.

## G. REFERENCE BOOKS

R1. Geankoplis, C. J., Transport Processes and Unit Operations, 3rd ed., PHI, New Delhi, 2000.

R2. Foust, A.S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., Principles of Unit operations, 2nd ed., John Wiley and Sons, 1980.

R3. McCabe and Smith, Unit Operations in Chemical Engineering, 5th ed., McGraw-Hill, NY, 1993

R4. Hill, G. B., Cooling towers principles and practice, BH, London, 1990.

R5. Sinnott, R. K., Coulson & Richardson's Chemical Engineering Design: Chemical Engineering Design: Vol. 6, 2006.

## H. LECTURE PLAN

| Lecture No. | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode Of Assessing CO |
|---|---|---|---|---|---|
| 1. | Introduction | Learn the mechanism and Classification of mass transfer operation | Lecture | CE1506.1 | Assignment / quiz / Mid Term I |
| 2. | Introduction | Gain knowledge about selection of separation method, methods of conducting mass transfer operations, Design principles | Lecture | CE1506.1 | Assignment / quiz / Mid Term I |
| 3. | Molecular diffusion in fluids | Learn the basics of steady state molecular diffusion in fluids at rest | Lecture | CE1506.1 | Assignment / quiz / Mid Term I |
| 4. | Molecular diffusion in fluids | Learn the basics of steady state molecular diffusion in fluids at rest and in laminar flow | Lecture | CE1506.1 | Assignment / quiz / Mid Term I |
| 5. | Molecular diffusion in fluids | Learn the basics of steady state molecular diffusion in fluids in laminar flow | Lecture | CE1506.1 | Assignment / quiz / Mid Term I |
| 6. | Mass Transfer coefficients | Gain knowledge about the significance of mass transfer coefficients and must be able to calculate the Mass Transfer Coefficients | Lecture | CE1506.2 | Assignment / quiz / Mid Term II |
| 7. | Mass Transfer coefficients | Gain knowledge about the significance of mass transfer coefficients and must be able to calculate the Mass Transfer Coefficients | Lecture | CE1506.2 | Assignment / quiz / Mid Term II |
| 8. | Mass Transfer coefficients | Gain knowledge about the significance of mass transfer coefficients and must be able to calculate the Mass Transfer Coefficients | Lecture | CE1506.2 | Assignment / quiz / Mid Term II |
| 9. | Mass Transfer coefficients | Gain knowledge about the significance of mass transfer coefficients and must be able to calculate the Mass Transfer Coefficients | Lecture | CE1506.2 | Assignment / quiz / Mid Term II |
| 10. | Interphase mass transfer | Learn the basics of Interphase mass transfer and equilibrium conditions | Lecture | CE1506.2 | Assignment / quiz / Mid Term II |
| 11. | Interphase mass transfer | Learn the basics of Interphase mass transfer and equilibrium conditions | Lecture | CE1506.2 | Assignment / quiz / Mid Term II |
| 12. | Interphase mass transfer | Learn the basics of Interphase mass transfer and equilibrium conditions | Lecture | CE1506.2 | Assignment / quiz / Mid Term II |
| 13. | Interphase mass transfer | Able to apply the material balances and calculate the number of stages | Lecture | CE1506.2 | Assignment / quiz / Mid Term II |

| | | | | | |
|---|---|---|---|---|---|
| 14. | Interphase mass transfer | Able to apply the material balances and calculate the number of stages | Lecture | CE1506.2 | Assignment / quiz / Mid Term II |
| 15. | Gas-Liquid Operations | Students will be introduced to the equipment for Gas-Liquid Operations | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 16. | Gas-Liquid Operations | Students will be introduced to the equipment for Gas-Liquid Operations | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 17. | Gas-Liquid Operations | Students will be introduced to the equipment for Gas-Liquid Operations | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 18. | Gas-Liquid Operations | Students will be introduced to the equipment for Gas-Liquid Operations | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 19. | Gas-Liquid Operations | Students will be introduced to the equipment for Gas-Liquid Operations | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 20. | Gas-Liquid Operations | Students will be introduced to the equipment for Gas-Liquid Operations | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 21. | Gas-Liquid Operations | Students will understand the basics of Humidification operations | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 22. | Gas-Liquid Operations | Students will understand the basics of Humidification operations | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 23. | Gas-Liquid Operations | Students will understand the basics of Humidification operations | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 24. | Gas-Liquid Operations | Gain knowledge about the types of Humidification equipment | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 25. | Gas-Liquid Operations | Be able to Design a cooling tower | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 26. | Gas-Liquid Operations | Be able to Design a cooling tower | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 27. | Gas-Liquid Operations | Be able to Design a cooling tower | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 28. | Gas-Liquid Operations | Able to learn the fundamentals of Gas absorption | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 29. | Gas-Liquid Operations | Able to learn the fundamentals of Gas absorption | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 30. | Gas-Liquid Operations | Students will be introduced to gas absorption equipment | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / Mid Term II |
| 31. | Gas-Liquid Operations | Be able to Design Gas absorption towers | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 32. | Gas-Liquid Operations | Be able to Design Gas absorption towers | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 33. | Gas-Liquid Operations | Be able to Design Gas absorption towers | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 34. | Gas-Liquid Operations | Be able to Design Gas absorption towers | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 35. | Gas-Liquid Operations | Be able to Design Gas absorption towers | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 36. | Gas-Liquid Operations | Be able to Design Gas absorption towers | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |

| | | | | | |
|---|---|---|---|---|---|
| 37. | Solid-Fluid Operations | Be able to Design Gas absorption towers | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 38. | Solid-Fluid Operations | Understand the Fundamentals of Adsorption | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 39. | Solid-Fluid Operations | Understand the Fundamentals of Adsorption | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 40. | Solid-Fluid Operations | Be able to design equipment for adsorption | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 41. | Solid-Fluid Operations | Be able to design equipment for adsorption | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 42. | Solid-Fluid Operations | Be able to design equipment for adsorption | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |
| 43. | Solid-Fluid Operations | Be able to design equipment for adsorption | Lecture | CE1506.3 CE1506.4 | Assignment / quiz / End Term |

## I. COURSE ARTICULATION MATRIX: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| [CE1506.1] | Understand the basics of diffusional mass transfer | 3 | 2 | | | | | 1 | | 1 | | | 2 | 3 | | 1 |
| [CE1506.2] | Understand the concepts of interphase mass transfer and mass transfer coefficients | 2 | 2 | | 1 | | | 1 | | | | | 1 | 2 | 1 | |
| [CE1506.3] | Understand the mechanism of various mass transfer operations such as absorption, stripping, adsorption, and humidification | 2 | 2 | 1 | 2 | | | 1 | | | | 1 | 2 | 2 | 1 | 2 |
| [CE1506.4] | Develop skills to perform design calculations involved in various mass transfer operations | 3 | 1 | 3 | | 1 | 2 | | 1 | 1 | | 1 | 2 | 2 | 1 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering
Department of Chemical Engineering
Course Hand-out
Chemical Reaction Engineering I | CE 1507 | 3 Credits | 3 0 0 3
Session: Jul'19 – Nov'19 | Faculty: Dr. Abhishek Sharma | Class: B. Tech. (Chemical) V Semester

**A. Introduction:** The aim of a chemical engineer is to conduct the chemical reactions at controlled conditions in such a manner so as to achieve maximum selectivity, yield and energy efficiency. This course on chemical reaction engineering combines the knowledge of chemical kinetics and thermodynamics that enables to decide upon the extent of reaction, rate of reaction, and process conditions. It introduces the basic concepts of reactor designing including elucidation of reaction rate and reaction mechanism, principles of chemical reactor design and analysis for homogeneous reactions, multiple reactors and their sequence, temperature and pressure effects, and selection of appropriate reactor and optimizing the reactor conditions.

**B. Course Outcomes:** At the end of the course, students will be able to:

| | |
|---|---|
| **[1507.1]** | Analyze and interpret the reaction systems and reaction kinetics |
| **[1507.2]** | Analyze experimental kinetic data to determine reaction mechanisms |
| **[1507.3]** | Design the ideal reactors (isothermal Batch, CSTR, and PFR) |
| **[1507.4]** | Develop skills to choose the right reactor among single, multiple, recycle reactors |
| **[1507.5]** | Understand and apply the concepts of heat capacity and heat of reaction in non-isothermal systems |

**C. Program Outcomes and Program Specific Outcomes**

**[PO.1]. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**[PO.2]. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**[PO.3]. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**[PO.4]. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**[PO.5]. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**[PO.6]. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**[PO.7]. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**[PO.8]. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**[PO.9]. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**[PO.10]. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**[PO.12]. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant.

**[PSO.2]. Process Intensification:** graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | Quizzes/Home and Class Assignments (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who miss a class will not be provided with any sort of makeup assignment or make up quiz. If you miss a lecture, you yourself have to study the topics that were covered during that particular lecture. However, you may contact the course coordinator for clarification of doubts, if any. | |

## E. Syllabus

Kinetics of homogeneous chemical reactions, Rate expressions, Temperature dependence of rate Differential, integral, half-life and total pressure method theories, Elementary and Non elementary reaction kinetics - Pseudo, steady state hypothesis mechanism. Isothermal reactor design. Design of batch, semi-batch, CSTR's and PFR's. Multiple reactor systems, Reactors in series or/and parallel, CSTRs series Performance analysis, Batch, Semi-Batch, Continuous and Recycle reactors. Multiple reaction systems, Series and parallel reactions in flow reactors, Product distribution, Yield and

selectivity. Maximizing the desired product in parallel reactions, Different reactors and schemes for minimizing the unwanted product, maximizing the desired product in series reactions.

**F. Books**

- Levenspiel, O., Chemical Reaction Engineering, 3rd ed., Wiley India Pvt Ltd
- Fogler, H. S., Elements of Chemical Reaction Engineering, 4th ed., Prentice-Hall of India, Delhi, 2003.

**G. Reference Books**

- Smith, J. M., Chemical Engineering Kinetics, 3rd ed., McGraw-Hill, 1981.
- Levenspiel, O., The Chemical Reactor Omnibook, OSU Bookstores, Corvallis Oregon, 1993.
- Froment, G. F., and Bischoff, K. B., Chemical Reactor Analysis and Design, 3rd ed., John Wiley and Sons, 2010.
- Richardson, J.F., and Peacock D.G., Coulson and Richardson's Chemical Engineering, vol. 3, 3rd ed., Asian Books Pvt. Ltd., New Delhi, 1998.

**H. Lecture Plan**

| lecture | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode Of Assessing CO |
|---|---|---|---|---|---|
| 1 | Overview of Chemical Reaction Engineering | Acquainted with basic knowledge of chemical reactions | Lecture | 1507.1 | Mid Term I, Quiz/Assignment & End Term |
| 2 | Kinetics of homogeneous chemical reactions, reactor types, rate expressions, Concentration dependent term of a rate equation, kinetic models, testing and validation. | Understanding the fundamentals of chemical rate equations | Lecture | 1507.1 | Mid Term I, Quiz/Assignment & End Term |
| 3 | Temperature dependent term of rate equation and reaction mechanism | Understanding the fundamentals of chemical rate equations | Lecture | 1507.1 | Mid Term I, Quiz/Assignment & End Term |
| 4 | Temperature dependent term of rate equation and reaction mechanism | Understanding the fundamentals of chemical rate equations | Lecture | 1507.1 | Mid Term I, Quiz/Assignment & End Term |
| 5 | Interpretation of Batch reactor data: Constant volume batch reactor, Integral Method of data analysis: Irreversible unimolecular type I order reactions | Acquiring the knowledge of methods for calculating reaction rate parameters | Lecture | 1507.2 | Mid Term I, Quiz/Assignment & End Term |

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|---|---|---|---|---|---|
| 6 | Irreversible bimolecular type II order reactions | Acquiring the knowledge of methods for calculating reaction rate parameters | Lecture | 1507.2 | Mid Term I, Quiz/Assignment & End Term |
| 7 | Irreversible trimolecular type III order reactions, empirical nth order reactions | Acquiring the knowledge of methods for calculating reaction rate parameters | Lecture | 1507.2 | Mid Term I, Quiz/Assignment & End Term |
| 8 | Irreversible trimolecular type III order reactions, empirical nth order reactions | Acquiring the knowledge of methods for calculating reaction rate parameters | Lecture | 1507.2 | Mid Term I, Quiz/Assignment & End Term |
| 9 | Zero-order reactions, Overall order by half-life and fractional-life method | Acquiring the knowledge of methods for calculating reaction rate parameters | Lecture | 1507.2 | Mid Term I, Quiz/Assignment & End Term |
| 10 | Irreversible reaction in parallel, homogeneous catalyzed reactions, Autocatalytic reactions | Acquiring the knowledge of methods for calculating reaction rate parameters | Lecture | 1507.2 | Mid Term I, Quiz/Assignment & End Term |
| 11 | Irreversible reactions in series, first-order and second-order reversible reactions, reversible reactions in series | Acquiring the knowledge of methods for calculating reaction rate parameters | Lecture | 1507.2 | Mid Term I, Quiz/Assignment & End Term |
| 12 | Irreversible reactions in series, first-order and second-order reversible reactions, reversible reactions in series | Acquiring the knowledge of methods for calculating reaction rate parameters | Lecture | 1507.2 | Mid Term I, Quiz/Assignment & End Term |
| 13 | Differential method of data analysis, varying volume batch reactor | Acquiring the knowledge of methods for calculating reaction rate parameters | Lecture | 1507.2 | Mid Term I, Quiz/Assignment & End Term |
| 14 | Introduction to reactor design, ideal reactors for a single reactions, ideal batch reactor, space time and space velocity | Grasping the principles for solving chemical | Lecture | 1507.3 | Mid Term I, Quiz/Assignment & End Term |

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|---|---|---|---|---|---|
| | | reactor design problems | | | |
| 15 | Review I | | Lecture | | Mid Term I, Quiz/Assignment & End Term |
| 16 | Steady-State Mixed flow reactor | Grasping the principles for solving chemical reactor design problems | Lecture | 1507.3 | Mid Term II, Quiz/Assignment & End Term |
| 17 | Steady-State Plug flow reactor | Grasping the principles for solving chemical reactor design problems | Lecture | 1507.3 | Mid Term II, Quiz/Assignment & End Term |
| 18 | Holding time and space time for flow reactors | Grasping the principles for solving chemical reactor design problems | Lecture | 1507.3 | Mid Term II, Quiz/Assignment & End Term |
| 19 | Design for single reactions, Size comparison of single reactors | Grasping the principles for solving chemical reactor design problems | Lecture | 1507.3 | Mid Term II, Quiz/Assignment & End Term |
| 20 | Multiple reactor systems, Plug flow reactor in series | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |
| 21 | Mixed flow reactors in series | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |
| 22 | Recycle reactors | Developing the fundamental knowledge for solving complex chemical | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |

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|---|---|---|---|---|---|
| | | reactor design problems | | | |
| 23 | Autocatalytic reactions | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |
| 24 | Design for parallel reactions: introduction to multiple reactions | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |
| 25 | Quantitative treatment of product distribution and of reactor size | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |
| 26 | Quantitative treatment of product distribution and of reactor size | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |
| 27 | Multiple reactions: Irreversible first order reaction in series | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |
| 28 | First order followed by zero-order reaction, Zero-order followed by first order reaction | Developing the fundamental knowledge for solving complex chemical | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |

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|---|---|---|---|---|---|
| | | reactor design problems | | | |
| 29 | Reversible reactions | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |
| 30 | Irreversible series parallel reactions | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Mid Term II, Quiz/Assignment & End Term |
| 31 | Review II | | Lecture | | Mid Term II, Quiz/Assignment & End Term |
| 32 | Temperature and Pressure Effects: Single reactions | Analyzing the effect of operating conditions on Reaction kinetics | Lecture | 1507.5 | Quiz/Assignment & End Term |
| 33 | Equilibrium constants from thermodynamics | Analyzing the effect of operating conditions on Reaction kinetics | Lecture | 1507.5 | Quiz/Assignment & End Term |
| 34 | Multiple reactions | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Quiz/Assignment & End Term |
| 35 | Choosing the right kind of reactor | Developing the fundamental knowledge for solving complex chemical reactor design problems | Lecture | 1507.4 | Quiz/Assignment & End Term |

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|---|---|---|---|---|---|
| 36 | Overall Review | | Lecture | | Quiz/Assignment & End Term |

## I. Course Articulation Matrix: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| [1507.1] | Analyze and interpret the reaction systems and reaction kinetics | 2 | 3 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | 2 | 1 | 1 | |
| [1507.2] | Analyze experimental kinetic data to determine reaction mechanisms | 2 | 2 | 1 | 2 | 1 | | 1 | | 1 | 2 | | | 2 | | 1 |
| [1507.3] | Design the ideal reactors (isothermal Batch, CSTR, and PFR) | 2 | 3 | | 2 | | 1 | 1 | | 1 | | | 2 | 1 | 2 | |
| [1507.4] | Develop skills to choose the right reactor among single, multiple, recycle reactors | 1 | 3 | 1 | | | 2 | 2 | | 2 | 1 | | 2 | 2 | 3 | 1 |
| [1507.5] | Understand and apply the concepts of heat capacity and heat of reaction in non-isothermal systems | 1 | 1 | 1 | | 1 | 1 | 2 | | 1 | | 1 | | 1 | 1 | 1 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

## J. Course Outcome Attainment Level Matrix:

| CO | STATEMENT | ATTAINMENT OF PROGRAM OUTCOMES THRESHOLD VALUE: 30% | | | | | | | | | | | | ATTAINMENT OF PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| [1507.1] | Analyze and interpret the reaction systems and reaction kinetics | | | | | | | | | | | | | | | |
| [1507.2] | Analyze experimental kinetic data to determine reaction mechanisms | | | | | | | | | | | | | | | |
| [1507.3] | Design the ideal reactors (isothermal Batch, CSTR, and PFR) | | | | | | | | | | | | | | | |
| [1507.4] | Develop skills to choose the right reactor among single, multiple, recycle reactors | | | | | | | | | | | | | | | |
| [1507.5] | Understand and apply the concepts of heat capacity and heat of reaction in non-isothermal systems | | | | | | | | | | | | | | | |

**0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Petroleum Production Technologies | CE 1553 | 3 Credits | 3 0 0 3

Session: Aug 18 – Dec 18 | Faculty: Anand Chakinala | Class: Program Elective

**A. Introduction:** This material on Petroleum Production Technologies is a program elective designed for the undergraduate students of Chemical Engineering under petroleum engineering as minors. The objective of the course is to provide a handy guideline to designing, analysing and optimizing petroleum production systems. The students are introduced to the concepts of petroleum production systems, properties of oil, gas and produced water and performance of oil & gas production wells as well as addressing production enhancement techniques such as matrix acidizing, hydraulic fracturing. They are also introduced to the concepts of midstream operations of natural gas processing like acid gas treatment, natural gas compression. This course also addresses designing acidizing jobs, tubing design and separation and dehydration systems.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1553.1].** Understand the basic operations of an upstream & midstream petroleum production process
**[1553.2].** Estimate the properties of oil, natural gas and produced water using correlations
**[1553.3].** Calculate the reservoir deliverability and well deliverability
**[1553.4].** Design equipment's for the upstream and midstream processes thus developing the skills required for employment
**[1553.5].** Design acidizing jobs for enhanced oil production

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Outcomes for B.Tech. in chemical engineering are as follows.

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**[PSO.2]. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes, Assignments, Projects, Case studies (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | No make-up for missed short quizzes/assignments or exam will be allowed except in extenuating circumstances, with prior permission of the instructor(s), and the decision of the instructor(s) in this regard shall be final. | |
| Homework/ Home Assignment/ Project (Formative) | Home works will be assigned in between the lectures along with the due date for handing it over. No late assignments handed after the due date shall be accepted under any circumstance. It is expected that the students shall work on the assignments independently and not 'copy' the solutions from each other. Group projects are assigned which is assessed in the form of individual reports submitted. | |

## E. SYLLABUS

**Introduction to Petroleum production technologies*:*** Reservoir, well, separators, pumps and pipelines, compressors, safety controls, **Properties of crude oil, natural gas and produced water**: Review of gas properties, crude oil properties, produced water properties, **Petroleum production from**: *Under saturated oil reservoirs*- Transient flow, pseudo steady state flow, steady state well performance, horizontal well production, effect of water production, *Two-phase reservoirs*- Two phase flow, inflow performance relationship (IPR), Generalized VOGEL IPR, other approximations, *Natural gas reservoirs*- Gas well deliverability, approximations, transient flow, horizontal IPR, **Well bore and choke performance:** Single phase flow of incompressible and compressible, Multiphase flow, Flow through chokes-Single phase liquid flow and gas flow, **Artificial lift methods**: Sucker rod pumping, Gas lift, Plunger lift, Introduction to enhanced oil recovery, **Matrix acidizing:** Acid rock interaction, Carbonate acidizing design, sandstone acidizing design, Hydraulic fracturing,

**Midstream operations of natural gas processing:** Process modules, Processing objectives, effect of gas type in field processing, Phase separation, Gravity separators, Multistage separation, Centrifugal separators, Slug catchers, gas-liquid coalescers, Acid gas treatment, Batch processes, amine processes, carbonate washing and water washing, Methanol based process, other processes, process selection, Sulfur recovery process, **Natural gas compression:** Thermodynamics of gas compression, Liquefaction processes, types and selection of compressors, Compressor design, control and performance maps, **Equipment design and selection**: Well tubing, separation systems, transportation systems.

## F. TEXT BOOKS


**1)** B.Guo, W.C. Lyons, A. Ghalambor, Petroleum Production Engineering, 3rd ed., Gulf professional publishing, 2007.


## G. REFERENCE BOOKS


**1)** B.Guo, A. Ghalambor, Natural Gas Engineering Handbook, Gulf professional publishing, 2005.

**2)** Dake L.P., Fundamentals of reservoir engineering, Elsevier, 1978.

**3)** Smith H.C., Tracy G.W., Farrar R.L., Applied Reservoir Engineering, Vol I and II, OGCL, 1999.

**4)** Economides, M.J., Daniel Hill, A., Economides, C.E., Petroleum Production Systems, Prentice Hall Inc., 1994.

**5)** Abdel-Aal, H.K., Aggour, M., Fahim, M.A., Petroleum and Gas Field Processing, Marcel Dekker Inc., 2003.


**Lecture Plan:**

| LEC NO | TOPICS | Session outcome | Mode of Delivery | Corresponding CO | Mode of assessing CO |
|---|---|---|---|---|---|
| 1-2 | Introduction to Petroleum production technologies | Brief overview of Crude oil production | Lecture | 1553.1 | Mid Term-1, End term |
| 3-5 | Properties of crude oil, natural gas and produced water | Estimation of the crude properties using empirical equations | Lecture + Tutorial | 1553.2 | Mid Term-1, End term |
| 6-10 | Petroleum production from: Under saturated oil reservoirs, Two-phase reservoirs, Natural gas reservoirs | Prediction of IPR for different reservoirs | Lecture + Tutorial | 1553.3 | Mid Term-1, End term, Assignment-1 |
| 11-14 | Well bore and choke performance | Prediction of TPR and pressure drop | Lecture + Tutorial | 1553.3 | Mid Term-2, End term, Assignment-2 |
| 5-9 | Artificial lift methods | To acquaint with several lift methods | Lecture | 1553.3 | Mid Term-2, End term |
| 10-13 | Matrix acidizing | To be able to determine the amount of acid consumption | Lecture + Tutorial | 1553.5 | Mid Term-2, End term |
| 14 | Hydraulic fracturing | Brief overview of the concept | Lecture | 1553.5 | Mid Term-2, End term, Assignment-3 |
| 15-19 | Midstream operations of natural gas processing | To familiarize with mid-stream operations and phase seperation | Lecture | 1553.4 | End term |
| 20-23 | Phase separation | | Lecture | 1553.4 | End term |
| 24-29 | Acid gas treatment | To be able to design separation systems | Lecture | 1553.4 | End term |
| 30-32 | Natural gas compression | | Lecture | 1553.4 | End term |
| 33 - 36 | Equipment design and selection | To be able to design tubing, separation systems and transportation systems | Lecture + Tutorial | 1553.4 | End term, Assignment-4 |

**H. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | *PSO1* | *PSO2* | *PSO3* |
| CE1553.1 | Understand the basic operations of an upstream & midstream petroleum production process | 2 | 1 | | 1 | | | | | | | | | 1 | | 3 |
| CE1553.2 | Estimate the properties of oil, natural gas and produced water using correlations | 2 | 1 | | 1 | 2 | | | | | | | | 1 | | 3 |
| CE1553.3 | Calculate the reservoir deliverability and well deliverability | 2 | 1 | | 1 | 2 | | | | | | | | 1 | | 3 |
| CE1553.4 | Design equipment's for the upstream and midstream processes | | 2 | 1 | 1 | 2 | 1 | 1 | 1 | | | | | 2 | 1 | 3 |
| CE1553.5 | Design acidizing jobs for enhanced oil production | | 1 | 1 | 1 | 2 | 1 | 2 | 1 | | | | | 2 | 1 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

**I. Course Outcome Attainment Level Matrix:**

| CO | STATEMENT | ATTAINMENT OF PROGRAM OUTCOMES **THRESHOLD VALUE: 30%** | | | | | | | | | | | | *ATTAINMENT OF PROGRAM SPECIFIC OUTCOMES* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | *PSO1* | *PSO2* | *PSO3* |
| CE1553.1 | Understand the basic operations of an upstream & midstream petroleum production process | | | | | | | | | | | | | | | |
| CE1553.2 | Estimate the properties of oil, natural gas and produced water using correlations | | | | | | | | | | | | | | | |
| CE1553.3 | Calculate the reservoir deliverability and well deliverability | | | | | | | | | | | | | | | |
| CE1553.4 | Design equipment's for the upstream and midstream processes | | | | | | | | | | | | | | | |
| CE1553.5 | Design acidizing jobs for enhanced oil production | | | | | | | | | | | | | | | |

**0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Conventional and Non-Conventional Energy Resources | CE 1554 | 3 Credits | 3 0 0 3

Session: July 19 – Nov 19 | Faculty: Dr. Anees Ahmed Yunus Khan| Class: B.Tech III Year

**Introduction:** This course focuses on the generation of available and derived forms of energy for different industrial applications. In this course, the students will learn about both conventional and non-conventional energy resources such as coal, natural gas, oil, biomass, hydro, wind and solar. By the end of this course, the students will have a better understanding of energy harnessing methods from different sources around the world.

## A. Course Outcomes: At the end of the course, students will be able to

[1554.1] List and explain the main sources of energy and their primary applications.

[1554.2] Describe the challenges and problems associated with the use of various energy resources, including fossil fuels, with regard to future supply and the environment.

[1554.3] Develop the skills to explain the principles and outline the technologies to deliver useable energy from conventional and non-conventional energy resources.

[1554.4] Identify issues facing the non-conventional energy industries.

[1554.5] Identify planning and environmental issues related to non-conventional energy systems.

## B. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**PO.1** **Engineering Knowledge:** A thorough knowledge of the basic science, engineering and mathematics and apply that to the underline practice of Chemical Engineering.

**PO.2** **Problem Analysis:** Ability to apply these basic principles to solve real world problems in a broad range of career paths.

**PO.3** **Project management and finance:** The skills of making smart decisions on process feasibility based in technical and economic evaluation.

**PO.4** **Ethics**: The ability to appreciate the social, ethical, cultural, environmental and safety issues related to chemical engineering profession.

**PO.5** **Conduct investigations of complex problems**: The ability to develop experimental procedure/protocol to test hypothesis and analysis meaningful interpretation of the generated data.

**PO.6** **Environment and sustainability**: The skill to generate sustainable engineering solutions to societal and industrial problems.

**PO.7** **Modern tool usage**: Proficiency to use computational tools for problem solving.

**PO.8** **Communication**: ability to communicate effectively (technical and non-technical context) in written and oral form.

**PO.9** **Design/development of solutions**: Skills to work effectively and professionally in multi-disciplinary groups to solve complex chemical engineering problems.

**PO.10** **Individual and team work**: The ability to work effectively and professionally on projects both independently and as a part of a group/team.

**PO.11** **Life-long learning**: The ability to be self-learners and lifelong learners.

**PO.12** **The engineer and society**: The motivation to develop and lead entrepreneurial projects for societal benefit.

Degree Specific Outcomes for chemical engineering are as follows:

**PSO.1** **Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant.

**PSO.2** **Process Intensification:** Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3** **Specialization:** students will be specialized in the areas of petroleum, energy and environment related fields.

## C. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes, Assignments AND Projects (Accumulated and Averaged) | 15+15 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | No makeup assignments will be given. | |
| Projects | Each group of 2-3 students will submit a project on a topic relevant to relevant to conventional and non-conventional energy production techniques. The details of this component will be discussed during the lectures. | |

## D. SYLLABUS

Introduction of coal, natural gas and oil as sources of energy. Application of coal in industries. In situ Coal Gasification. Oil and Gas from condensate and oilfields. Scope of Oil and Natural gas industry. Concepts of thermodynamics and system energy in Natural Gas Engineering. Physical properties of natural gas and the associated hydrocarbon liquids. Reservoir aspects of natural gas and oil. Conversion of coal and gas to liquid. Introduction to world energy scenario, Renewable energy resources, Radiation, Solar Geometry, radiation models; Solar Thermal, Optical efficiency, thermal efficiency, concentrators, testing procedures, introduction to thermal systems (flat plate collector), Biomass, Biomass resources, wood composition, biogas, biodiesel, ethanol; Wind, types of wind machines, Hydro resources, types of hydro turbine, small hydro systems; Other systems, Geothermal, wave energy, ocean energy.

## E. BOOKS

**Reference Books:**


- Probstein, R. F., and Hicks, R. E., Synthetic Fuels, Dover Publications, 2013.
- S. Rao and B.B. Parulekar, Energy technology, Khanna Publishers, 2017.
- P.C. Jain, Engineering Chemistry, Dhanpat Rai Publishing Company, 2018.
- D. D. Hall and R. P. Grover, Biomass Regenerable Energy, John Wiley, 1987.
- J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, 1986.
- Sukhatme, S. P., Solar Energy - Principles of Thermal Collection and Storage, 3rd ed., Tata McGraw-Hill, 1996.
- Duffie, J. A., and Beckman, W. A., Solar Engineering of Thermal Processes, 4th ed., John Wiley, 2013.
- Goswami, D. Y., Kreith, F., and Kreider, J. F., Principles of Solar Engineering, Taylor and Francis, 2000.
- Green, Solar Cells, Prentice-Hall, Englewood Cliffs, 1982.

**F. Lecture Plan:**

| Class Number | Topics | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introduction to World Energy Resources | List and explain the main sources of energy and their primary applications | Lecture and interaction | CO 1 | Quiz |
| 2 | Introduction of coal, natural gas and oil as sources of energy. Application of coal in industries | List and explain the main sources of energy and their primary applications | Lecture and interaction | CO 1<br>CO 2 | |
| 3 | Oil and Gas from condensate and oilfields. Scope of Oil and Natural gas industry. | Describe the challenges and problems associated with the use of various energy resources, including fossil fuels, with regard to future supply and the environment. | Lecture and interaction | CO 1<br>CO 2 | Quiz<br>1st Sessional<br>ET Exam<br>Home Assignment |
| 4 | Concepts of thermodynamics and system energy in Natural Gas Engineering. | | | | |
| 5-6 | Physical properties of natural gas and the associated hydrocarbon liquids. Reservoir aspects of natural gas and oil. Conversion of coal and gas to liquid. | | | | |
| 7-12 | Oil and Natural Gas Production Techniques | | Lecture and interaction | CO 1<br>CO 2 | 1st Sessional |

| | | | | | |
|---|---|---|---|---|---|
| 13-20 | Nuclear Processes, Nuclear decay, Nuclear fuel processing, Life cycle of nuclear fuel, Nuclear reactor types and applications. | Explain the principles and outline the technologies to deliver useable energy from conventional and non-conventional energy resources. | | | ET Exam<br>Home Assignment<br>Quiz<br>Project |
| | Hydroelectric power: Design considerations for a hydroelectric power plant, classification of hydroelectric power plants, flow duration and power duration curve, Selection of turbine, power load factor. | Identify issues facing the non-conventional energy industries.<br><br>Identify planning and environmental issues related to non-conventional energy systems. | Lecture and interaction | CO 1<br>CO 2<br>CO 3<br>CO 4 | |
| First sessional exam | | | | | |
| 21-23 | Biomass, Biomass resources, wood composition, biogas, biodiesel, ethanol. | Identify planning and environmental issues related to non-conventional energy systems. | Lecture and interaction | CO 3<br>CO 4<br>CO 5 | Quiz<br><br>II Sessional<br><br>ET Exam<br><br>Home Assignment<br>Project |
| 24-26 | Wind, types of wind machines, Energy generation from wind. | Identify planning and environmental issues related to non-conventional energy systems. | Lecture and interaction | CO 3<br>CO 4<br>CO 5 | |
| 27-28 | Introduction to world energy scenario, Renewable energy resources, Radiation, Solar Geometry, radiation models | Identify planning and environmental issues related to non-conventional energy systems. | Lecture and interaction | CO 3<br>CO 4<br>CO 5 | |
| 29-30 | Solar Thermal, Optical efficiency, thermal efficiency, concentrators, testing procedures, | Identify planning and environmental issues related to non-conventional energy systems. | Lecture and interaction | CO 3<br>CO 4<br>CO 5 | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| Second sessional exam | | | | | |
| 30-32 | Introduction to solar thermal systems (flat plate collector). | List and explain the main sources of energy and their primary applications | Lecture and interaction | CO 3<br>CO 4<br>CO 5 | ET Exam<br><br>Home Assignment<br>Quiz<br>Project |
| 33-40 | Other non-conventional energy sources such as Geothermal, wave energy, ocean energy. | List and explain the main sources of energy and their primary applications<br><br>Identify planning and environmental issues related to non-conventional energy systems. | Lecture and interaction | | |
| End term exam | | | | | |

**G. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| [1554.1] | List and explain the main sources of energy and their primary applications. | | | 1 | | | 1 | 1 | | | | | | | | 3 |
| [1554.2] | Describe the challenges and problems associated with the use of various energy resources, including fossil fuels, with regard to future supply and the environment. | | | 1 | | | 2 | 3 | | | 1 | | | | | 3 |
| [1554.3] | Explain the principles and outline the technologies to deliver useable energy from conventional and non-conventional energy resources. | | | 1 | | | 2 | 2 | | | | | | | | 3 |
| [1554.4] | Identify issues facing the non-conventional energy industries. | | 3 | | 1 | | | | 1 | 1 | | | | | | 3 |
| [1554.5] | Identify planning and environmental issues related to non-conventional energy systems. | | | | | 3 | 1 | 1 | | | | | 1 | | | 3 |

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Process Safety Analysis | CE 1604 | 3 Credits | 3 0 0 3

Session: Jan 20 – May 20 | Faculty: Dr. Harsh Pandey | Class: Core course

**A. Introduction:** This material on Process Safety Analysis is designed for the undergraduate students of Chemical Engineering. This course introduces the basic concepts relating to chemical hazards, risk, and ethics. The interaction and trade-offs of these concepts are stressed in order to establish approaches to the proper selection and evaluation of processes and their implementation into small and large scale plants/laboratories. Quantitative analyses of chemical releases and dispersion using thermodynamic, transport, and reaction/reactor considerations are used to develop an appreciation for and understanding of chemical incidents and the possible consequences to plant facilities, workers, and the general public. Examples of problems that may arise due to inadequate process design, improper process modification, and disregard for ethical decision making are discussed using numerous case studies.

**B. Course Outcomes:** At the end of the course, students will be able to

| | |
|---|---|
| **[1604.1]** | Develop safety culture |
| **[1604.2]** | Evaluate effect of toxicants and other hazards |
| **[1604.3]** | Quantitatively analyse release and dispersion rates of liquid and vapors |
| **[1604.4]** | Analyse fire and explosion hazards |
| **[1604.5]** | Integrate safety concepts and ethics into chemical process design |
| **[1604.6]** | Perform hazard identification, risk assessment, enhancing employability. |

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

*Program Outcomes for B.Tech. in chemical engineering are as follows*.

The Graduates of Chemical Engineering from MUJ will have:

**[PO.1].** **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2].** **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3].** **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

**[PO.4].** **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**[PO.5].** **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6].** **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

**[PO.7].** **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8].** **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9].** **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10].** **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11].** **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12].** **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

**[PSO.1].** Concept to Commissioning: The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant.

**[PSO.2].** Process Intensification: graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3].** Specialization: Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes, Assignments, Projects, Case Studies (Accumulated and Averaged) | 30 |
| End Term Exam | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments | No make-up for missed short quizzes/assignments or exam will be allowed except in extenuating circumstances, with prior permission of the instructor(s), and the decision of the instructor(s) in this regard shall be final. | |
| Homework/ Home Assignment/ Project | Home works will be assigned in between the lectures along with the due date for handing it over. No late assignments handed after the due date shall be accepted under any circumstance. It is expected that the students shall work on the assignments independently and not 'copy' the solutions from each other. A case study is given which is assessed in form of individual reports submitted. | |

## E. SYLLABUS

**Introduction** – Accident and loss statistics, inherent safety, safety culture, ethics; **Toxicology**- How toxicants enter and are eliminated from biological organisms, Toxicological studies, Dose vs response, Relative toxicity, threshold limit values; **Industrial Hygiene:** Government regulations, Identification, Evaluation of exposures to volatile toxicants, dusts, noise, toxic vapors, Control; **Source Models:** Flow of liquid through hole, hole in a tank, pipes; Flow of vapor through holes, gases through pipes; Flashing liquids, Liquid pool evaporation or boiling, Toxic Release and dispersion models; **Fires and explosion:** Fire triangle, fire vs explosion, Flammability characteristics of liquid and vapors, TNT equivalency, energy of chemical and mechanical explosions, vapor cloud explosions, BLEVE, Inerting, Static electricity, Explosion proof equipment and instruments, Sprinkler systems; **Relief systems:** Relief concepts, Location of reliefs, Relief scenarios, Relief systems for flares, scrubbers, condensers, knock out drum; **Relief sizing:** Spring operated for liquid/vapor/gas service, Rupture disk relief for liquid/vapor/gas, reliefs for thermal expansion of process fluids; **Hazard Identification:** Surveys, HAZOP, safety reviews **Risk assessment:** Probability theory, event trees, fault trees, QRA, LOPA, **Accident investigations**

## F. TEXT BOOKS

1. Crowl, D.A., Louvar, J.F., Chemical Process Safety, Pearson, 3rd edition, 2015.

## G. REFERENCE BOOKS

1. Center for Chemical Process Safety (CCPS), Introduction to process safety for undergraduates and engineers, Wiley, 1st Edition, 2016.
2. Sanders, R. E., Chemical Process Safety, Elsevier, 3rd edition, 2006.
3. Klein, J.A., Vaughen, B.K., Process Safety: Key concepts and practical approaches, CRC press, 1st edition, 2017.

## H. Lecture Plan:

| Class Number | Topics | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introduction to Safety | To introduce chemical process safety to the students | Lecture, Interaction | CE1604.1 | NA |
| 2-4 | Toxicology | Introducing concepts related to toxicity and exposure to the students | Interaction, Discussion | CE1604.2 | Assignment |
| 5-7 | Industrial Hygiene | Introduces industrial hygiene and best practices to the students | Interaction, Discussion | CE1604.2, CE1604.5 | Assignment |
| 8-10 | Source Models | This key concept for understanding release of hazardous materials is introduced | Interaction, Discussion | CE1604.2, CE1604.3 | Assignment |
| 11 | Flashing liquids, Liquid pool evaporation or boiling | Students learn about these fire and explosion hazards | Interaction, Discussion | CE1604.4 | Assignment |
| 12 | Pre-Sessional Review | Review of Syllabus Covered | Discussion | CE1604.1, CE1604.2, CE1604.3, CE1604.4 | NA |
| FIRST SESSIONAL EXAM | | | | | |
| 13-16 | Toxic Release and dispersion models | This key concept for understanding release and spreading of hazardous materials is introduced | Interaction, Discussion | CE1604.2, CE1604.3 | Assignment |
| 17-20 | Fires | Students learn about these fire and explosion hazards | Interaction, Discussion | CE1604.4 | Assignment |

| | | | | | |
|---|---|---|---|---|---|
| 21-23 | Explosions | Students learn about these fire and explosion hazards | Interaction, Discussion | CE1604.4 | Assignment |
| 24-27 | Inerting, Static electricity, Explosion proof equipment and instruments, Sprinkler systems | Students learn about preventing and minimizing damage from fire and explosion hazards | Interaction, Discussion | CE1604.4 | Assignment |
| 28 | Relief concepts, Location of reliefs, Relief scenarios | Students learn about preventing and minimizing damage from fire and explosion, toxicity, and other hazards | Interaction, Discussion | CE1604.1, CE1604.2, CE1604.3, CE1604.4, CE1604.5 | Assignment |
| 29 | Relief systems for flares, scrubbers, condensers, knock out drum | Students learn about preventing and minimizing damage from fire and explosion, toxicity, and other hazards | Interaction, Discussion | CE1604.1, CE1604.2, CE1604.3, CE1604.4, CE1604.5 | Assignment |
| 30-34 | Relief sizing | Students learn about preventing and minimizing damage from fire and explosion, toxicity, and other hazards | Interaction, Discussion | CE1604.1, CE1604.2, CE1604.3, CE1604.4, CE1604.5 | Assignment |
| 35 | Pre-Sessional Review | Review of Syllabus Covered | Discussion | CE1604.1, CE1604.2, CE1604.3, CE1604.4, CE1604.5 | NA |
| SECOND SESSIONAL EXAM | | | | | |
| 36-39 | Hazard Identification and Risk Assessment | Students learn about the formal approaches to Hazard Identification and Risk Assessment standardized by Industry | Interaction, Discussion | CE1604.6 | NA |
| 40-42 | Accident investigations | Students learn about some major industrial disasters, what went wrong, and the lessons learnt from them | Discussion, Class Participation | CE1604.1, CE1604.2, CE1604.3, CE1604.4, CE1604.5, CE1604.6 | Miniproject Report |
| END TERM EXAM | | | | | |

**I. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | *PSO1* | *PSO2* | *PSO3* |
| CE 1604.1 | Develop safety culture | | | | 3 | | | | | | | | | 2 | | 1 |
| CE 1604.2 | Evaluate effect of toxicants and other hazards | 1 | | | 2 | | | 1 | | | | | | 2 | | |
| CE 1604.3 | Quantitatively analyse release and dispersion rates of liquid and vapors | 1 | | | 2 | | | 2 | | | | | | 2 | 1 | |
| CE 1604.4 | Analyse fire and explosion hazards | 1 | | | 2 | | | 2 | | | | | | 2 | | 1 |
| CE 1604.5 | Integrate safety concepts and ethics into chemical process design | | | 1 | 2 | | | | | | | | | 2 | | 1 |
| CE 1604.6 | Perform hazard identification, risk assessment, enhancing employability. | | | 2 | | | | | | | | | | 2 | | 1 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

**MANIPAL UNIVERSITY JAIPUR**
School of Civil and Chemical Engineering
Department of Chemical Engineering
Course Handout
Mass Transfer II | CE1605 | 3 Credits | 3 0 0 3
Session: Jan'20 – May'20 | Faculty: Dr. Manisha Sharma | Class: B. Tech. (Chemical)
VI Semester

## A. INTRODUCTION

This course on Mass Transfer II is a core course designed for the undergraduate students of Chemical Engineering. This course continues further on the concepts learned in Mass Transfer-I which describes interphase mass transfer involved in design of separation systems. It covers the concepts of vapour-liquid, liquid-liquid, solid-liquid equilibrium involved in mass transfer operations with emphasis on design and performance calculations of rate based and equilibrium-based separations. Separation processes covered in detail in this course are distillation, extraction, leaching and drying.

## B. COURSE OUTCOMES

At the end of the course, students will be able to:

| | |
|---|---|
| **[CE1605.1]** | Interpret the equilibrium data required in design of separation processes |
| **[CE1605.2]** | Illustrate the mass transfer fundamentals involved in design calculations |
| **[CE1605.3]** | Use the design methods for solving problems related to mass transfer operations in industries |
| **[CE1605.4]** | Perform process design calculations of various mass transfer equipment such as distillation columns, extraction columns and dryers enhancing employability |

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

The Graduates of Chemical Engineering from MUJ will have:

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**PSO.1. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**PSO.2. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. ASSESSMENT PLAN

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | Quizzes and Home Assignments / Class Assignments (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Assignments (Formative) | Assignments are an integral part of the course. Home assignments / Class assignments will be provided from time to time. No late submissions will be entertained. It is expected that the students will work on the assignments independently. If any assignment is found copied from any source, marks will be deducted for the same. | |
| Make up Assignments | Students who miss a class will not be provided with any sort of makeup assignment or make up quiz. If you miss a lecture, you yourself have to study the topics that were covered during that particular lecture(s). You may contact the course coordinator for clarification of doubts, if any. | |

## E. SYLLABUS

Distillation, concept of vapour liquid equilibrium, Raoult's law, deviations from ideal law, azeotropic distillation and steam distillation. Enthalpy concentration diagrams, binary and multi component systems, dew and bubble point calculations, flash vaporization, simple distillation, binary component distillation, Ponchan Savarit method: minimum reflux ratio, optimum reflux

ratio- total reflux ratio, partial condenser, total condenser, McCabe Thiele method: concept of q line, optimum reflux ratio- total reflux ratio, partial condenser, total condenser. Multi component distillation: azeotropic, extractive, molecular distillation. Liquid-Liquid Extraction: liquid-liquid-equilibria, ternary systems triangular and rectangular coordinates-choice of solvent-single stage and multi stage cross current, equipment's such as mixer settler, packed and tray towers. Leaching, Drying and design criteria, Design of rotary dryers.

## F. TEXT BOOKS

T1. Treybal R. E, Mass Transfer Operations, 3rd ed., McGraw Hill, 2012

## G. REFERENCE BOOKS


R1. Seader, J.D., Henley, E.J., Roper D.K., "Separation Process Principles," 3rd ed., (International Edition), John Wiley & Sons.

R2. McCabe and Smith, Unit Operations in Chemical Engineering, 5th ed., McGraw-Hill.

R3. Coulson, J.M., Richardson, J.F., Chemical Engineering Volume-2, 5th ed., Butterworth-Heinemann.

R4. Geankoplis, C. J., Transport Processes and Unit Operations, 3rd ed., PHI, New Delhi.

R5. Robert H. Perry and Don W. Green, Perry's Chemical Engineers hand book, 8th ed., McGraw Hill.

R6. King, C. J., Separation Processes, 2nd ed., Tata McGraw Hill, New Delhi.


## H. LECTURE PLAN

| Lecture No. | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode Of Assessing CO |
|---|---|---|---|---|---|
| 1. | Introduction | Understand the basics of Mass Transfer Operations | Lecture | - | Assignment / quiz / Mid Term I |
| 2. | Introduction | Understand the basics of Mass Transfer Operations | Lecture | - | Assignment / quiz / Mid Term I |
| 3. | Distillation | Vapor liquid equilibrium, concept of relative volatility | Lecture | CE1605.1 | Assignment / quiz / Mid Term I |
| 4. | Distillation | Effect of P and T on equilibrium data, P-x-y and T-x-y diagrams, y vs x diagrams | Lecture | CE1605.1 | Assignment / quiz / Mid Term I |
| 5. | Distillation | Ideal Solutions, Raoult's law, Deviations from ideality, Maximum and minimum boiling azeotrope | Lecture | CE1605.1 | Assignment / quiz / Mid Term I |
| 6. | Distillation | Bubble and dew point calculations | Lecture | CE1605.1 | Assignment / quiz / Mid Term I |
| 7. | Distillation | Bubble and dew point calculations | Lecture | CE1605.1 | Assignment / quiz / Mid Term I |
| 8. | Distillation | Enthalpy concentration diagrams | Lecture | CE1605.1 | Assignment / quiz / Mid Term I |
| 9. | Distillation | Single stage flash distillation | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term I |
| 10. | Distillation | Steam distillation | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term I |
| 11. | Distillation | Simple distillation binary and multicomponent mixtures | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term I |
| 12. | Distillation | Continuous rectification of binary systems | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term I |
| 13. | Distillation | Determination of number of stages by Ponchon Savarit method, case study | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term I |
| 14. | Distillation | Determination of number of stages by Ponchon Savarit method, case study | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term I |

| | | | | | |
|---|---|---|---|---|---|
| 15. | Distillation | Determination of number of stages by Ponchon Savarit method, case study | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term I |
| 16. | Distillation | Determination of number of stages by Mc-Cabe Thiele method, Case study | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 17. | Distillation | Determination of number of stages by Mc-Cabe Thiele method, Case study | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 18. | Distillation | Partial and total condenser, Concept of minimum, total and optimum reflux ratio | Lecture | CE1605.2; CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 19. | Distillation | Partial and total condenser, Concept of minimum, total and optimum reflux ratio | Lecture | CE1605.2; CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 20. | Distillation | Partial and total condenser, Concept of minimum, total and optimum reflux ratio | Lecture | CE1605.2; CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 21. | Distillation | Use of open steam | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term II |
| 22. | Distillation | Azeotropic distillation, extractive distillation | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term II |
| 23. | Distillation | Concept of multi-component distillation | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term II |
| 24. | Extraction | Liquid-Liquid equilibrium, Choice of solvent | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term II |
| 25. | Extraction | Ternary diagrams | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term II |
| 26. | Extraction | Design calculations for miscible solvents (co-current and counter current) | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 27. | Extraction | Design calculations for miscible solvents (co-current and counter current) | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 28. | Extraction | Design calculations for miscible solvents (co-current and counter current) | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 29. | Extraction | Design calculations for immiscible solvents (co-current and counter current) | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 30. | Extraction | Design calculations for immiscible solvents (co-current and counter current) | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / Mid Term II |
| 31. | Extraction | Types of extractors | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / Mid Term II |
| 32. | Leaching | Solid liquid equilibrium | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / End Term |
| 33. | Leaching | Leaching equipment | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / End Term |
| 34. | Leaching | Single and multistage operation | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / End Term |
| 35. | Leaching | Single and multistage operation | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / End Term |
| 36. | Leaching | Single and multistage operation | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / End Term |
| 37. | Drying | Equilibrium relationship and hysteresis, types of moisture | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / End Term |
| 38. | Drying | Mechanism of drying, rate of drying | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / End Term |
| 39. | Drying | Drying equipment | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / End Term |
| 40. | Drying | Drying equipment | Lecture | CE1605.1; CE1605.2 | Assignment / quiz / End Term |
| 41. | Drying | Design of Batch, continuous dryers | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / End Term |
| 42. | Drying | Design of Batch, continuous dryers | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / End Term |
| 43. | Drying | Cross-circulation drying, Freeze drying | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / End Term |
| 44. | Drying | Cross-circulation drying, Freeze drying | Lecture | CE1605.3; CE1605.4 | Assignment / quiz / End Term |

## I. COURSE ARTICULATION MATRIX: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| [CE1605.1] | Interpret the equilibrium data required in design of separation processes | 3 | 3 | | | | | 2 | | | | 1 | | 3 | | 2 |
| [CE1605.2] | Illustrate the mass transfer fundamentals involved in design calculations | 3 | 1 | | | | | 2 | | | 1 | | 1 | 3 | | 2 |
| [CE1605.3] | Use the design methods for solving problems related to mass transfer operations in industries | 3 | 3 | | | 2 | | 2 | | 2 | | 1 | | 3 | | 2 |
| [CE1605.4] | Perform process design calculations of various mass transfer equipment such as distillation columns, extraction columns and dryers enhancing employability | 3 | 3 | 1 | | 2 | | 2 | | 2 | 2 | 1 | | 3 | | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Chemical Reaction Engineering II| CE 1606 | 3 Credits | 3 0 0 3

Session: Jan' 20 – May' 20 | Faculty: Dr Abhishek Sharma| Class: B. Tech. (Chemical) VI Semester

**Introduction:** This course is offered by Dept. of Chemical Engineering as a core course. This course focuses on the design of chemical reacting systems. In this unit, the students will learn the basics of non-ideal reactors, heterogeneously reacting systems and application of real reactors available in process plants and industries. By the end of this course, the students will have a clear understanding required for troubleshooting the design related problems of chemical reactors in real world.

**A. Course Outcomes:** At the end of the course, students will be able to

**[1606.1]** Understand the fundamentals of Residence Time Distribution in chemical reactors

**[1606.2]** Utilize different Flow Models to understand non-ideal reactor behaviour

**[1606.3]** Analyze the heterogeneous and solid catalysed reactions for industrial applications

**[1606.4]** Evaluate the performance of different industrial reactors such as packed bed, fluidized bed, and three phase reactors

**[1606.5]** Apply the detailed kinetics for design of fluid-fluid and fluid-particle systems

## B. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**PO.1** **Engineering Knowledge:** A thorough knowledge of the basic science, engineering and mathematics and apply that to the underline practice of Chemical Engineering.

**PO.2** **Problem Analysis:** Ability to apply these basic principles to solve real world problems in a broad range of career paths.

**PO.3** **Project management and finance:** The skills of making smart decisions on process feasibility based in technical and economic evaluation.

**PO.4** **Ethics**: The ability to appreciate the social, ethical, cultural, environmental and safety issues related to chemical engineering profession.

**PO.5** **Conduct investigations of complex problems**: The ability to develop experimental procedure/protocol to test hypothesis and analysis meaningful interpretation of the generated data.

**PO.6** **Environment and sustainability**: The skill to generate sustainable engineering solutions to societal and industrial problems.

**PO.7** **Modern tool usage**: Proficiency to use computational tools for problem solving.

**PO.8** **Communication**: ability to communicate effectively (technical and non-technical context) in written and oral form.

**PO.9** **Design/development of solutions**: Skills to work effectively and professionally in multi-disciplinary groups to solve complex chemical engineering problems.

**PO.10** **Individual and team work**: The ability to work effectively and professionally on projects both independently and as a part of a group/team.

**PO.11** **Life-long learning**: The ability to be self-learners and lifelong learners.

**PO.12** **The engineer and society**: The motivation to develop and lead entrepreneurial projects for societal benefit.

Degree Specific Outcomes for chemical engineering are as follows:

**PSO.1** **Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant.

**PSO.2** **Process Intensification:** Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3** **Specialization:** students will be specialized in the areas of petroleum, energy and environment related fields.

## C. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes, Assignments, Mini-Project (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | No makeup assignments will be given. | |
| Projects | Each group of 2-3 students will submit a project on a topic relevant to the design of chemical reactors applicable in process plants. The details of this component will be discussed during the lectures. | |

## D. SYLLABUS

Isothermal non-ideal flow reactors, RTD in chemical reactors, distribution functions. Conversion in non-ideal flow reactors, Single and multi-parameter models for non-ideal flow, Concepts of mixing, Micro and macro mixing. Heterogeneous reactions, Rate equation for heterogeneous systems, Contacting patterns for two phase systems, Fluid particle non-catalytic reactions, Different models, Derivation of rate equations, Application to design Fluid-fluid non- catalytic reactions. Introduction to Slurry, Trickle bed reactors, and Fluidized bed reactors.

## E. BOOKS

Fogler, H. S., Elements of Chemical Reaction Engineering, 4th ed., Prentice-Hall of India, Delhi, 2003.
Levenspiel, O., Chemical Reaction Engineering, 3rd ed., Wiley India Pvt Ltd., 2010.
Smith, J. M., Chemical Engineering Kinetics, 3rd ed., McGraw-Hill, 1981.
Carberry, J. J., Catalytic Reaction Engineering, McGraw-Hill, 1976.
Levenspiel, O., The Chemical Reactor Omnibook, OSU Bookstores, Corvallis Oregon, 1993.
Froment, G. F., and Bischoff, K. B., Chemical Reactor Analysis and Design, 3rd ed., John Wiley and Sons, 2010.

**F. Lecture Plan:**

| Lec No | Topics | Session Outcomes | Model of Delivery | Corresponding CO | Mode of assessing the outcome |
|---|---|---|---|---|---|
| 1,2,3 | Revision of Chemical Reaction Engineering-I | Revise the fundamentals with applications taught in Chemical Reaction Engineering I Course | Lecture | NA | NA |
| 4 | RTD Concept | Introducing the concept of Residence Time Distribution | Lecture | 1606.1 | Mid-Term I<br>End Term<br>Assignment/Quiz/Mini Project |
| 5 | Age Distribution of Fluid | Introducing the experimental methods for calculating age distribution of fluids | Lecture | 1606.1 | Mid-Term I<br>End Term<br>Assignment/Quiz/Mini Project |
| 6 | Step and Pulse Experiments, Convolution Integral | Explaining the applied methods for mean residence time and exit age distribution (E) calculation | Lecture | 1606.1 | Mid-Term I<br>End Term<br>Assignment/Quiz/Mini Project |
| 7 | Non Ideal Reactor Conversion | Calculating the conversion in non-ideal flow reactors | Lecture | 1606.1 | Mid-Term I<br>End Term<br>Assignment/Quiz/Mini Project |
| 8,9,10 | Non Ideal Flow Models- Compartment Model | Explaining the fundamentals of compartment model for E calculations | Lecture | 1606.2 | Mid-Term I<br>End Term<br>Assignment/Quiz/Mini Project |
| 11,12,13 | Non Ideal Flow Models- Dispersion Model | Explaining the fundamentals of dispersion model for E calculations | Lecture | 1606.2 | Mid-Term I<br>End Term<br>Assignment/Quiz/Mini Project |
| 14,15,16 | Non Ideal Flow Models- Tank In Series Model | Explaining the fundamentals of tank in series model for E calculations | Lecture | 1606.2 | Mid-Term I<br>End Term<br>Assignment/Quiz/Mini Project |
| 17,18,19 | Non Ideal Flow Models- Pure Convective Model | Explaining the fundamentals of pure convective model for E calculations | Lecture | 1606.2 | Mid-Term I<br>End Term<br>Assignment/Quiz/Mini Project |
| 20 | Mixing Concepts | Introducing the concepts of degree of segregation and earliness of mixing in RTD calculation | Lecture | 1606.2 | Mid-Term I<br>End Term<br>Assignment/Quiz/Mini Project |

| | | | | | |
|---|---|---|---|---|---|
| 21,22 | Heterogeneous Reactions-Introduction | Introducing the heterogeneous chemical engineering systems | Lecture | 1606.3 | Mid-Term II<br>End Term<br>Assignment/Quiz/Mini Project |
| 22,24,25,26 | Solid Catalysed Reactions | Explaining the mechanism of heterogeneous reactions in presence of solid catalysts and evaluating the performance of different flow reactors | Lecture | 1606.3 | Mid-Term II<br>End Term<br>Assignment/Quiz/Mini Project |
| 27,28 | Packed Bed Catalytic Reactors | Describing the basics of packed bed reactors with performance evaluation for different design considerations | Lecture | 1606.4 | Mid-Term II<br>End Term<br>Assignment/Quiz/Mini Project |
| 29,30,31 | Fluidized Bed Catalytic Reactors | Explaining the behaviour and performance of fluidized bed reactors using different hydrodynamic models | Lecture | 1606.4 | Mid-Term II<br>End Term<br>Assignment/Quiz/Mini Project |
| 32,33 | Catalyst Deactivation | Explaining the catalyst decay mechanism and its effect on reactor performance | Lecture | 1606.4 | Mid-Term II<br>End Term<br>Assignment/Quiz/Mini Project |
| 34,35,36 | Three Phase Reactors | Describing the fundamentals of three phase reactors with their performance evaluation | Lecture | 1606.4 | Mid-Term II<br>End Term<br>Assignment/Quiz/Mini Project |
| 37,38,39 | Fluid-Fluid Reactions: Kinetics and Design | Explaining the factors involved in kinetic estimation and designing of fluid-fluid reactions | Lecture | 1606.5 | End Term<br>Assignment/Quiz/Mini Project |
| 40,41,42 | Fluid-Particle Reactions: Kinetics and Design | Explaining the factors involved in kinetic estimation and designing of fluid-particle reactions | Lecture | 1606.5 | End Term<br>Assignment/Quiz/Mini Project |

**G. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1606.1 | Understand the fundamentals of Residence Time Distribution in chemical reactors | 3 | 3 | | | | | 1 | 2 | 3 | 2 | | | | 1 | |
| CE 1606.2 | Utilize different Flow Models to understand non-ideal reactor behaviour | 3 | 3 | | | | | 1 | 2 | 3 | 2 | | | | 1 | |
| CE 1606.3 | Analyze the heterogeneous and solid catalysed reactions for industrial applications | 3 | 3 | | | | | 1 | 2 | 3 | 2 | | | | 1 | |
| CE 1606.4 | Evaluate the performance of different industrial reactors such as packed bed, fluidized bed, and three phase reactors | 3 | 3 | | | | | 1 | 2 | 3 | 2 | | | | 1 | |
| CE 1606.5 | Apply the detailed kinetics for design of fluid-fluid and fluid-particle systems | 3 | 3 | | | | | 1 | 2 | 3 | 2 | | | | 1 | |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

**MANIPAL UNIVERSITY JAIPUR**

School of Civil and Chemical Engineering

Department of Chemical Engineering

Course Hand-out

Petroleum Refining Technology| CE 1653 | 3 Credits | 3 0 0 3

Session: Jan 20 – May 20 | Faculty: Ir. Nandana Chakinala | Class: Elective course

**A. Introduction:** Petroleum refining technology is a program elective course offered by chemical engineering department targeting students who wish to acquire enough background to pursue his/her specific area of interest in detail. This course presents the basic concepts of petroleum refining technology in a systematic manner and make the students appreciate the major refining processes. It trains the student to perform complete material and energy balances around the major refinery units.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1653.1].** To estimate the properties and specifications of crude/petroleum products and evaluate the crude oils

**[1653.2].** Describe major refinery operations and its significance

**[1653.3].** Interpret and illustrate the effect of operating parameters on performance of major refinery operations

**[1653.4].** Enhance the problem-solving skills by carrying out material balances around the major refinery units

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Outcomes for B.Tech. in chemical engineering are as follows.

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**PSO.1. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**PSO.2. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | No make-up for missed quizzes/assignments shall be allowed except in emergency situations with prior permission of the instructor. | |
| Homework/ Home Assignment/ Quiz (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. Un-announced quizzes will be part of the lecture/tutorial. | |

## E. SYLLABUS

Petroleum resources, petroleum industry in India. Composition and classification of petroleum crude, ASTM, TBP and FEV distillation. Refinery flowsheet-overview, Properties and specifications of petroleum products – LPG, Gasoline, naphtha, kerosene, diesel oil, lubricating oil, wax etc. Crude distillation-Atmospheric and Vacuum, Design and operation of topping and vacuum distillation units. Tube still furnaces. Solvent extraction processes for lubricating oil base stocks and for aromatics from naphtha and kerosene, solvent dewaxing. Thermal and catalytic cracking, vis-breaking and coking processes, reforming, hydro processing, alkylation, polymerization and isomerization, Utilities-Hydrogen production, Product blending, Sulphur recovery. Economics, Safety and pollution considerations in refineries.

## F. TEXT BOOKS

1) J.H. Gary, G.E. Handwerk and M.J. Kaiser, Petroleum Refining – Technology and Economics, 5th ed., CRC Press, New York, 2007

## G. REFERENCE BOOKS

**1)** Nelson, W. L., Petroleum Refinery Engineering, 4th ed., McGraw Hill, 1987
**2)** Rao, B.K.B., Modern Petroleum Refining Processes, Oxford, IBH, 2008
**3)** Watkins, R.N. Petroleum Refinery Distillation, 2nd ed., Gulf Publishing, Houston, TX, 1979
**4)** API Petroleum Refining Handbook, 1989
**5)** R.J Hengstebeck, Petroleum Processing, Mc Graw Hill, New York
**6)** J.G Speight, The Chemistry and Technology of Petroleum, 3rd ed., Marcel-Dekker, 1999
**7)** J.G Speight and Baki Ozum, Petroleum refining processes (Chemical Industries), CRC Press

**Lecture Plan:**

| LEC NO | TOPICS | Session Outcome | Mode of Delivery | Corresponding CO | Mode of assessing CO |
|---|---|---|---|---|---|
| 1 | Introduction to conventional crude oil resources, oil wells, world-wide oil distribution, oil usage | To understand the significance of crude oil in todays economy | Lecture | | Quiz, Mid term I, End Term |
| 2 | *Refinery process flowsheet* – Major operations | To understand the major unit operations of petroleum refinery | Lecture | 1653.2 | Quiz/Assignment, Mid term I, End Term |
| 3 | *Refinery products* - Physical and Chemical properties | To identify and estimate the specifications of crude and petroleum products | Lecture | 1653.1 | Quiz/Assignment, Mid term I & End term |
| 4 | *Refinery feedstocks* - Crude oil properties and crude oil classification | To estimate the properties of crude /petroleum products and evaluate the crude oils | Lecture | 1653.1 | Quiz/Assignment, Mid term I & End term |
| 5-6 | *Crude distillation* – TBP and gravity mid percent curves | To understand different types of graphs associated with refinery calculations | Lecture | 1653.1 | Assignment, Mid term I & End term |
| 7-8 | *Crude distillation* – Atmospheric and Vacuum distillation, Typical boiling range cut fractions | To understand the fractionation of crude oil and analyse the petroleum cuts | Lecture | 1653.2 & 1653.3 | Quiz, Mid term II & End term |
| 9 | *Coking* – Types, Properties and uses of petroleum coke | To acquire knowledge of various types of cokes and their application | Lecture | 1653.2 | Quiz, Mid term II & End term |
| 10,11 | *Coking* – Delayed coking, Flexi coking and Fluid coking | To acquaint major process operations in refinery and understand its significance | Lecture | 1653.2 & 1653.3 | Quiz/Assignment, Mid term II & End term |
| 12 | *Coking* – Material balance delayed coker | To understand and perform material balance of coking unit | Lecture | 1653.4 | Assignment, Quiz, Mid term II & End term |
| 13,14 | *Fluid Catalytic Cracking* – Process, New designs of FCC-Regenerator system | To acquire knowledge of significant conversion processes of crude to petroleum products | Lecture | 1653.2 & 1653.3 | Quiz/Assignment, Mid term II & End term |

| | | | | | |
|---|---|---|---|---|---|
| 15-17 | *Fluid Catalytic Cracking* – Cracking reactions, Process variables, Yield estimation, Case-study | To understand the effect of various process variables on performance of FCC | Lecture | 1653.3 & 1653.4 | Quiz/Assignment, Mid term II & End term |
| 18, 19 | *Catalytic Reforming and Isomerization* – Process, Reactions, Reactor design | To understand the effect of various process variables on performance of reforming unit | Lecture | 1653.2 & 1653.3 | Assignment, Mid term II & End term |
| 20 | *Catalytic Reforming and Isomerization* – Isomerization Yields, Capital and Operating costs, case study | To perform material balance of catalytic reformer and isomerization unit | Lecture | 1653.4 | Mid term II & End term |
| 21 | *Hydrotreating* – Process Variables, Reactions | To understand the effect of various process variables on performance of hydrotreating | Lecture | 1653.3 | Quiz, Mid term I, End Term |
| 22 | *Hydrotreating* - material balance Case study | To understand and perform material balance of coking unit | Case study | 1653.4 | |
| 23 | *Catalytic Hydrocracking* – Process, Process Variables | To understand the effect of various process variables on performance of hydrocracking unit | Lecture | 1653.3 | Quiz/Assignment, Mid term I, End Term |
| 24 | *Catalytic Hydrocracking* – Hydrocracking yields, Material balance case study | To understand and perform material balance of coking unit | Case study | 1653.4 | Quiz/Assignment, Mid term I & End term |
| 25, 26 | *Alkylation and Polymerization* – Feedstocks, Types of Process, Comparison of processes | To understand the significance of alkylation process | Lecture | 1653.2 | Quiz/Assignment, Mid term I & End term |
| 27, 28 | *Alkylation and Polymerization* –Process variables, Reactions, Yields | To understand and perform material balance of coking unit | Lecture | 1653.4 | Assignment, Mid term I & End term |
| 29 | *Supporting processes* – Hydrogen production, Gas processing | To acquire the knowledge of gas processing operations in refinery | Lecture | 1653.2 | Quiz/Assignment, Mid term II & End term |
| 30 | *Supporting processes* – Acid gas removal, Sulfur recovery processes | To acquire the knowledge of various supporting processes in refinery | Lecture | 1653.2 | Quiz, Mid term II & End term |
| 31, 32 | *Product Blending* – Blending for Octane number, Blending for Reid Vapour Pressure, Blending for other properties | To acquire the knowledge of blending operations in refinery | Lecture | 1653.4 | Quiz, Mid term II & End term |
| 33,34 | *Product Blending* – Case studies | To perform blending calculations and enhancing problem solving skills | Case study | 1653.4 | Quiz/Assignment, Mid term II & End term |

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|---|---|---|---|---|---|
| 35 | *Lubricating oil blending stocks* – Propane deasphalting | To understand the Lube oil processing operations | Lecture | 1653.2 | Assignment, Quiz & End term |
| 36 | *Lubricating oil blending stocks* – Viscosity index improvement and solvent extraction | To understand the Lube oil processing operations | Lecture | 1653.2 | Quiz/Assignment, End term |
| 37 | *Lubricating oil blending stocks* – Dewaxing | To understand the Lube oil processing operations | Lecture | 1653.2 | End term |
| 38,39 | Economic Evaluation in refineries | To understand the refining costs and margins and its effect on oil markets | Lecture | 1653.4 | |

**H. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1653.1 | To estimate the properties and specifications of crude/petroleum products and evaluate the crude oils | 2 | 2 | | | | | | | | | | | 2 | | 3 |
| CE 1653.2 | Describe major refinery operations and its significance | 2 | 2 | | 1 | | | | 2 | 3 | | 2 | | 1 | | 3 |
| CE 1653.3 | Interpret and illustrate the effect of operating parameters on performance of refinery operations | 2 | 2 | | 1 | | | 2 | 1 | 1 | | | | 2 | | 3 |
| CE 1653.4 | Enhance the problem-solving skills by carrying out material balances around the major refinery units | 2 | 2 | | | | 2 | | | | | | | 2 | | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Environmental Systems Engineering | CE 1654/1652 | 4 Credits | 3 1 0 4

Session: January 20 – May 20 | Faculty: Dr. Anees Y. Khan | Class: VI Semester

**A. Introduction:** This course is designed to bring together and integrate in a single text the more general subject matter of the three principal areas of environmental engineering-air, water and solid-waste management. In this course, students will be introduced with a unique approach to the overall concept of environmental engineering, an approach that emphasizes the relationship between the principles observed in natural purification processes and those employed in engineered processes.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1654.1].** Define, analyse and quantify the environmental quality in describing physical, chemical, mathematical and biological principles.

**[1654.2].** Understand the processes by which the environment assimilates waste material/pollution from human activities and industries.

**[1654.3].** Have a clear understanding of engineering principles and practices involved in the design and operation of conventional environmental engineering works.

**[1654.4].** Acquire the fundamental knowledge of different treatment technologies to curb environmental pollution-air, water and solid-wastes.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Outcomes for B.Tech. in chemical engineering are as follows.

The Graduates of Chemical Engineering from MUJ will have:

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**[PSO.2]. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.
**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book + Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of **75% Attendance** is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home & Class Assignment (Formative) | Home works will be assigned in between the lectures along with the due date for handing it over. No late assignments handed after the due date shall be accepted under any circumstance. Assignments will also be given during lecture hours. Students will be given open-ended problems/case-studies as a part of assignments. It is expected that the students shall work on the assignments independently and not 'copy' the solutions from each other. Students are encouraged to discuss problems with their instructor in lecture hours. Students are advised to meet the instructor in case of any difficulty related to assignments and course related matters. Total 10 assignments will be given. | |

## E. SYLLABUS

**Air Pollution-** fundamentals and standards, effects, origins, fate of pollutants, greenhouse effect, acid rain, ozone, dispersion of pollutants, control of stationary and mobile sources.

**Solid Wastes-** sources, management, processing, and disposal, Waste to Energy

**Hazardous Wastes-** definition & classification, sources, management, RCRA, HSWA, CERCLA and SARA- What are these? Treatment technologies and disposal

**Water Pollution-** water chemistry and water quality, water quality standards, treatment systems: coagulation and flocculation; sedimentation and filtration; disinfection, adsorption; membrane processes, Wastewater Characteristics- water quality, constituents, biochemical oxygen demand, dissolved oxygen sag curve, Analysis and Selection of Wastewater Flowrates and Constituents Loadings, standards, onsite, preliminary, primary, secondary and tertiary treatments, Treatment techniques – Physical unit operations; biological processes; chemical unit processes; sludge and biosolids treatment reuse and disposal. **Water Reuse**

## F. TEXT BOOKS

Davis and Cornwell, Introduction to Environmental Engineering, 5th edition, McGraw-Hill, 2014.
Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, 4th edition, McGraw-Hill, 2002.

## G. REFERENCE BOOKS

Masters, Gilbert. M., Ela, Wendell. P., *Introduction to Environmental Engineering and Science,* Pearson Education, Inc., 2015.

Peavy, H. S., Rowe, D. R., Tchobanoglous, G., *Environmental Engineering*, McGraw Hill, 2013.

Bhatia, S.C., *Environmental Pollution and Control in Chemical Process Industries*, Khanna Publishers, Delhi, 2001.

Perkins, Henry. C., *Air Pollution*, McGraw Hill, 1974.

**H. Lecture Plan:**

| Class Number | Topics | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1-2 | Introduction to Environmental System Engineering, Environmental acts and rules | Basic understanding of Environmental acts and rules | Lecture and interaction | CO 1 | In Class Quiz |
| 3-4 | Air Pollution – fundamentals and standards | Define, analyse and quantify the environmental quality in describing physical, chemical, mathematical and biological principles.<br><br>Acquire the fundamental knowledge of different treatment technologies to curb environmental pollution-air, water and solid-wastes | Lecture and interaction | CO 1 and CO 2 | |
| 5-6 | Air Pollution –effects, origins, fate of pollutants | | Lecture and interaction | | |
| 7-8 | Air Pollution – greenhouse effect, acid rain, ozone | | Lecture and interaction | | |
| 9-10 | Air Pollution – dispersion of pollutants | | Lecture and interaction | | 1st Sessional<br><br>Home Assignment |
| 11-13 | Air Pollution – control of stationary and mobile sources | | Lecture and interaction | | 1st Sessional<br><br>ET Exam<br><br>Home Assignment |
| 14-15 | Solid Wastes – sources, management | Understand the processes by which the environment assimilates waste material/pollution from human activities and industries | Lecture and interaction | CO 1 CO 2 | |
| 16-18 | Solid Wastes – processing, and disposal | | Lecture and interaction | | |
| | | | | | |
| First sessional exam | | | | | |
| 19 | Waste to Energy | | Lecture and interaction | | |
| 20 | Hazardous Wastes– definition & classification, sources, management | | Lecture and interaction | | |
| 21 | RCRA, HSWA, CERCLA and SARA- What are these? | | Lecture and interaction | | |
| 22-24 | Hazardous Wastes– treatment technologies and disposal | | Lecture and interaction | | II Sessional<br><br>Home Assignment |
| 25 | Water Pollution – water chemistry and water quality | Acquire the fundamental knowledge of | Lecture and interaction | CO 1<br>CO 2<br>CO 3 | |

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|---|---|---|---|---|---|
| 26 | Water Pollution – water quality standards, treatment systems | different treatment technologies to curb environmental pollution-air, water and solid-wastes | Lecture and interaction | | |
| 27 | Water Pollution – treatment system: coagulation and flocculation | | Lecture and interaction | | |
| 28-29 | Water Pollution – treatment system: sedimentation and filtration | | Lecture and interaction | | |
| 30-32 | Water Pollution – treatment system: disinfection, adsorption | | Lecture and interaction | | II Sessional<br>ET Exam<br>Home Assignment |
| 33 | Water Pollution – treatment system: membrane processes | | Lecture and interaction | | |
| 34 | Wastewater Characteristics- water quality, constituents | | Lecture and interaction | | |
| 35 | Wastewater – biochemical oxygen demand | | Lecture and interaction | | II Sessional<br>ET Exam<br>Home Assignment |
| | Wastewater – dissolved oxygen sag curve | | Lecture and interaction | | |
| Second sessional exam | | | | | |
| 36-37 | Analysis and Selection of Wastewater Flowrates and Constituents Loadings | Have a clear understanding of engineering principles and practices involved in the design and operation of conventional environmental engineering works. | Lecture and interaction | CO 3 | ET Exam<br>Home Assignment |
| 38 | Wastewater – standards, onsite, preliminary, primary, secondary and tertiary treatments | | | | |
| 39-45 | Wastewater treatment techniques – biological processes (selected) | | Lecture and interaction | CO 3 | |
| 46-48 | Wastewater treatment techniques – chemical unit processes (selected) | | Lecture and interaction | CO 3 | |

| | | | | | |
|---|---|---|---|---|---|
| 49-50 | Wastewater – sludge and biosolids treatment reuse and disposal | | Lecture and interaction | CO 3 | ET Exam<br><br>Home Assignment |
| End Term exams | | | | | |

## I. Course Articulation Matrix: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1654.1 | Define, analyse and quantify the environmental quality in describing physical, chemical, mathematical and biological principles | 3 | 3 | 0 | 2 | 1 | 3 | 3 | 3 | 0 | 0 | 2 | 0 | 1 | 1 | 3 |
| CE 1654.2 | Understand the processes by which the environment assimilates waste material/pollution from human activities and industries | 2 | 2 | 0 | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 1 | 0 | 2 | 1 | 0 |
| CE 1654.3 | Have a clear understanding of engineering principles and practices involved in the design and operation of conventional environmental engineering works | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 0 | 3 | 0 | 3 | 2 | 3 |
| CE 1654.4 | Acquire the fundamental knowledge of different treatment technologies to curb environmental pollution-air, water and solid-wastes | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 0 | 2 | 1 | 2 | 1 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Industrial Psychology | PS 1601 | 3 Credits | 3 0 0 3

Session: Jan 20 – May 20 | Faculty: Dr. Suyesha Singh | Semester: VI

A. **Introduction:** This course is offered by Department of Psychology as an elective course. Industrial Psychology is concerned with the study of human behaviour in those aspects of life that are related to the production, distribution and use of the goods and services in our civilization. "Workplace psychology "refers to the practice of applying psychological principles and practices to a work environment in order to solve problems and make improvements.

B. **Course Objectives:** At the end of the course, students will be able to:

**[PS1601.1]** Explain the nature, scope and methods of Industrial Psychology.

**[PS1601.2]** Comprehend principles and techniques of employee Selection and recruitment.

**[PS1601.3]** Acquire Skills required for conducting effective training and development in industrial setup

**[PS1601.4]** Understand the process of Job Performance Evaluation and Appraisal

**[PS1601.5]** Evaluate the implications of Physical working conditions, Work Schedules, Accidents and safety in work place

**[PS1601.6]** Critically evaluate and apply the theories of motivation, job satisfaction, job involvement

**[PS1601.7]** Acquire skills and learn techniques to maintain work-life balance and manage work stress

C. **PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

Program Outcomes for B. Tech. in Chemical Engineering are as follows.

The Graduates of Chemical Engineering from MUJ will have:

**PO.1** A thorough knowledge of the basic science, engineering and mathematics and apply that to the underline practice of Chemical Engineering

**PO.2** Ability to apply these basic principles to solve real world problems in a broad range of career paths

**PO.3** The skills of making smart decisions on process feasibility based in technical and economic evaluation

**PO.4** The ability to appreciate the social, ethical, cultural, environmental and safety issues related to chemical engineering profession

**PO.5** The ability to develop experimental procedure/protocol to test hypothesis and analysis meaningful interpretation of the generated data

**PO.6** The skill to generate sustainable engineering solutions to societal and industrial problems

**PO.7** Proficiency to use computational tools for problem solving

**PO.8** The ability to communicate effectively (technical and non-technical context) in written and oral form
**PO.9** Skills to work effectively and professionally in multi-disciplinary groups
**PO.10** The ability to work effectively and professionally on projects both independently and as a part of a group/team
**PO.11** The ability to be self-learners and lifelong learners
**PO.12** The motivation to develop and lead entrepreneurial projects for societal benefit

Degree Specific Outcomes for Chemical Engineering are as follows:

**PSO.1** The graduates will possess a working knowledge of fundamental principles such as basic chemistry, material and energy balances, physical and chemical equilibria, transport and rate processes, separation processes, chemical process control, reaction engineering
**POS.2** The graduates will be able to design sustainable chemical processes including techno-economic feasibility of the process
**PSO.3** The graduates will minor in either Petroleum Engineering or Energy and Environment depending on their choice of interest
**PSO.4** The graduates will have an aptitude for learning new innovative technologies in chemical and allied fields of chemical engineering or peruse advanced studies

D. **Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to | |

| | |
|---|---|
| (Formative) | participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. |

E. **SYLLABUS**

**Introduction to Industrial & Organizational Psychology (I/O):** Nature, scope and methods of study; Challenges for I/O psychology, problems for I/O psychologists; Human engineering. **Employee Selection and recruitment:** Principles and techniques. **Training & development:** Principles and techniques. **Job Performance Evaluation and Appraisal:** Meaning and nature, techniques. **Working conditions:** Physical working conditions, Work Schedules; Accidents and safety in work place. **Motivation and Work:** Theories of motivation, job satisfaction, job involvement. **Work stress and management:** Nature and meaning, sources, individual differences, consequences of job stress; Stress management techniques.

**TEXT BOOKS**

**T1:** Schultz, S.E & Schultz, D.P., Psychology and Work Today: An introduction to Industrial and Organisational Psychology. Pearson, 2014.

**T2:** Landy, F.L. & Conte, J.M.2nd Edition, Work in the 21st Century: An Introduction to Industrial and Organizational Psychology**.** Wiley India Private Limited,2009.

**REFERENCE BOOKS**

**R1:** Blum, M.L. & Naylor, J.C., Industrial psychology: Its theoretical and social foundations. New Delhi: CBS Publishers & Distributors, 2002.

**R2:** Riggio, R.R., Introduction to Industrial and Organizational Psychology. Routledge

**R3:** APA Handbook of industrial and organizational psychology-volumes: I, II& III, New York: American Psychological Association, 2011.

## F. Lecture Plan:

| Lec No. | Topics | Session Objective | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introduction and Course Hand-out briefing | To acquaint and clear teachers expectations and understand student expectations | Lecture | | NA |
| 2 | Introduction to Industrial & Organizational Psychology (I/O) | Define industrial psychology and its goals | Lecture | PS1601.1 | Written test, First Sessional and end Sem Exam |
| 4-5 | Nature, scope and methods of study | understand various research method used in industrial psychology and scope of the field | Lecture | PS1601.1 | |
| 6 | Challenges for I/O psychology, problems for I/O psychologists; Human engineering. | Discuss challenges and problems of an Industrial Psychologist | Lecture | PS1601.1 | Class test, First Sessional and end Sem Exam |
| 7-8 | Employee Selection and recruitment: Principles and techniques. | Understand the principles and process of employee selection | Lecture | PS1601.2 | Class test, First Sessional and end Sem Exam |
| 9-10 | psychological testing and assessment for employee selection & Job analysis | Explain role of psychological test in employee selection | Lecture | PS1601.2 | Class test, First Sessional and end Sem Exam |
| 11 | Test of Unit I and Unit II | Nature, scope, goals, methods of industrial psychology. Principles and practices in employee selection and recruitment. | | | Class test, First Sessional and end Sem Exam |
| 12 | Meaning and need of training in an organization | Discuss the importance training and development in an organization | Lecture | PS1601.3 | Class test, First Sessional and end Sem Exam |
| 13-15 | Steps of Training design | Design and execute a training and development programme | Experiential learning based on group activity | PS1601.3 | First Sessional and end Sem Exam |

| | | | | | |
|---|---|---|---|---|---|
| 16 | Techniques for Training | Apply various techniques of training as part of group task/activity | Group activity | PS1601.3 | Class test, First Sessional and end Sem Exam |
| 17 | Evaluation of Training Program | Critically evaluate the importance and implications of training programme | Lecture | PS1601.3 | Class test, First Sessional and end Sem Exam |
| 18 | Case Study | | | | |
| 19-21 | Meaning and importance of Job performance evaluation | Discuss the importance and implications of Job performance evaluation | Lecture | PS1601.4 | Class test, Second Sessional and end Sem Exam |
| 22-23 | Sources of Job performance evaluation | Identify sources of Job Performance evaluation | Lecture | PS1601.4 | Class test, Second Sessional and end Sem Exam |
| 24-25 | Appraisal rating systems and non-rating evaluation methods | Differentiate between rating and non-rating evaluation methods | Lecture | PS1601.4 | Class test, Second Sessional and end Sem Exam |
| 26 | Case study | | | | |
| 27 | Meaning of working condition | Discuss the major physical conditions that affects the employee health | Lecture | PS1601.5 | Class test, Second Sessional and end Sem Exam |
| 28 | Concept and types of Work Schedules | Explain how work schedules can affect employee health and well-being. | Lecture | PS1601.5 | Class test, Second Sessional and end Sem Exam |
| 29-30 | Occupational Health and Safety | Describe the causes of accident and steps that can be taken to prevent them. | Lecture | PS1601.5 | Class test, Second Sessional and end Sem Exam |
| 31 | Meaning of motivation and factor effecting motivation of employee | Discuss the term motivation and its factor effecting motivation of employee | Flipped classroom | PS1601.6 | Home Assignments, Second Sessional and end Sem Exam |
| 32-33 | Theories of motivation | Discuss various theory of motivation | Lecture | PS1601.6 | Class test, Second Sessional and end Sem Exam |

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|---|---|---|---|---|---|
| 34-35 | Job satisfaction and job involvement | Understand the concept of job satisfaction and its relationship with employee growth | Lecture | PS1601.6 | Class test Second Sessional and end Sem Exam |
| 36-37 | Nature and meaning of stress. | Discuss and describe work related stress and its consequences. | Lecture | PS1601.7 | Class test Second Sessional and end Sem Exam |
| 38-40 | Consequences of job stress; Stress management techniques | Learn skills and strategies to manage work related stress and maintain work-life balance. | Lecture | PS1601.7 | Class test Second Sessional and end Sem Exam |
| 41 | Case study | | | | |

## G. Course Articulation Matrix: (Mapping of COs with POs and PSOs)

| CO | Statement | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
| **[PS1601.1]** | Explain the nature, scope and methods of Industrial Psychology | | | 2 | | | | | | | | | | | | | |
| **[PS1601.2]** | Comprehend principles and techniques of employee Selection and recruitment | 1 | | 2 | | | | | | | | | | | | | |
| **[PS1601.3]** | Acquire Skills required for conducting effective training and development in industrial setup | | | | | | | | | | | | | | | | |
| **[PS1601.4]** | Understand the process of Job Performance Evaluation and Appraisal | | | 2 | | | | | | | | 1 | | | | | |
| **[PS1601.5]** | Evaluate the implications of Physical working conditions, Work Schedules, Accidents and safety in work place | | | | | | 3 | | | | | | | | | | |
| **[PS1601.6]** | Critically evaluate and apply the theories of motivation, job satisfaction, job involvement | | | | | | | | | | | | 3 | | | | |
| **[PS1601.7]** | Acquire skills and learn techniques to maintain work-life balance and manage work stress | | 2 | | | | | | 1 | | | | | | | | |

**H. Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Process Plant Design | CE 1705/1701 | 3/4 Credits | 3 0 0 3/3 1 0 4

Session: July – Dec 2019 | Faculty: Nandana Chakinala | Class: VII Semester

**A. Introduction:** This course on Process Plant Design is a core course designed for the undergraduate students of chemical engineering. This course provides the student an insight into various aspects of process design by coupling chemical engineering principles to the principles of economics. It covers in detail the preliminary process synthesis, developing base case design and use of heuristics for choosing the best from various process alternatives.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1705.1].** Understand concepts of process design and economics.

**[1705.2].** Analyse, synthesize and design processes for manufacturing products commercially.

**[1705.3].** Develop skills in designing equipment optimally based on economics and process considerations.

**[1705.4].** Use commercial flow sheeting software to simulate processes and design process equipment for enhancing employability in industries/consultancy firms.

**C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

Program Outcomes for B.Tech. in chemical engineering are as follows.

The Graduates of Chemical Engineering from MUJ will have:

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9.** Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**PSO.1 Concept to Commissioning**: The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**POS.2 Process Intensification**: graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3 Specialization**: Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. ASSESSMENT PLAN

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes, Assignments & Project | 30 |
| End Term Exam (Summative) | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | No make-up for missed quizzes/assignments shall be allowed except in emergency situations with prior permission of the instructor. | |

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|---|---|
| Home and Class Assignments and Project (Formative) | Home and Class assignments are integral part of this course. Mainly design oriented problems will be assigned along with the due date for handing it over. Projects shall be assigned at the beginning of the semester. Students are expected to work in groups. A detail project report and viva voce are part of the grading process for Mini project |

## E. SYLLABUS

**Process Design and Development**- The hierarchy of chemical process design, General design considerations, the nature of process synthesis & analysis, engineering economics, economic decision making

**Developing a conceptual design and finding the best flowsheet-** input information: batch vs continuous input-output structure flowsheet, recycle structure of flowsheet, separation system, heat exchanger networks, cost diagram and quick screening of process alternatives

**Plant Design**- Process design development and general design considerations

**Process Economics**- Economic feasibility of project using order-of-magnitude cost estimates, plant and equipment cost estimation, product cost estimation

**Design Tools and Application-** preliminary process optimization, Application of Aspen Plus in different processes.

## F. TEXT BOOKS

**T1** James M. Douglas, "Conceptual Design of Chemical Processes", McGraw Hill, New York, International Edition (1988).

**T2** Robin Smith, "Chemical Process Design", International Editions, McGraw Hill, Singapore (2000).

**T3** Warren D. Seider, J. D. Seader, and Daniel R. Lewin, "Product & Process Design Principles: Synthesis, Analysis, and Evaluation", Wiley-India Edition, India, 2nd Edition (2004).

## G. REFERENCE BOOKS

**R1** Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz, and Debangsu Bhattacharyya, "Analysis, Synthesis, and Design of Chemical Processes", International Edition, Pearson Education International, New Jersey (2012).

**R2** Dale F. Rudd, and Charles C. Watson, "Strategy of Process Engineering", John Wiley & Sons, New York (1968).

**R3** Max S. Peters, Klaus D. Timmerhaus and Ronald E. West, "Plant Design and Economics for Chemical Engineers", McGraw Hill India, 5th Edition, (2011).

## H. TUTORIALS

Short quizzes will be conducted during lecture hour. No late-comers will be allowed to take the quiz, MAKE SURE YOU ARE ON TIME! No make-up for missed short quizzes will be allowed. Problem discussion and solution shall also be a part of the tutorials.

## I. HOME/CLASS ASSIGNMENTS AND PROJECT

Home assignment is an integral part of this course. No late assignments/projects handed after the due date shall be accepted under any circumstance. It is expected that the students shall work on the assignments independently and not 'copy' the solutions from each other. All assignments are to be done in pen, only and are to be handed in on A4 size white paper

Conceptual design oriented problem/case study will be given as mini project. Students need to make use of Aspen Plus/ HYSYS to simulate the process flowsheet and design the major equipments in the process flow sheet. Students need to submit a project report detailing the study carried out, by the last instruction day.

## J. NOTICES

All notices concerning this course will be mailed to students. Students are responsible for regularly checking their group email ID.

## K. LECTURE PLAN

| Lecture No. | Topics to be covered | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing CO |
|---|---|---|---|---|---|
| 1-2 | Introduction to Process Design Decisions: Process Synthesis and Analysis. | To acquaint basic knowledge of synthesis and analysis | Lecture | 1705.1 | Quiz |
| 3-5 | Nature of Process Synthesis and Analysis: Creative aspects, Hierarchical approach to conceptual design, HDA Process. Preliminary Process Synthesis with examples. | To acquaint the basic steps of designing a process with few case studies | Lecture | 1705.1 | Quiz, Mid Term I, End Term |
| 6-8 | Conceptual Design of Chemical Processes: Flowsheet synthesis, Design aspects of Batch vs. Continuous, input/output structure of flowsheet, recycle structure of flowsheet | To perform material balances required in synthesizing a process flow sheet | Lecture | 1705.2 | Mid Term I, Quiz, End Term |
| 9-11 | Flowsheet Synthesis | Hands on calculation for synthesizing a process flow sheet | Tutorial | 1705.2 | Mid Term I, Assignment, End Term, Mini project |
| 12-14 | Basic principles of reactor design, Reactor non ideality, residence time distributions, types of reactors and selection criteria | To assess the reactor performance using design equations | Flipped Class | 1705.3 | Mid term I, Assignment and End term |
| 15-16 | Reactor design and cost estimation | Hands on calculations for reactor design | Tutorial | 1705.3 | Mid term I, Assignment and End term, Mini Project |

| | | | | | |
|---|---|---|---|---|---|
| 17-19 | Introduction, types of separations, criteria for selection of separation processes | To acquaint the basic knowledge of industrial separation processes | Lecture & Flipped Class | 1705.1 | Quiz |
| 20-24 | Design of Separation processes: Guidelines, design of distillation columns, energy integration of distillation columns, Tutorials on design of absorption column and distillation columns | To perform design calculations of the conventional separation units | Lecture & Tutorial | 1705.3 | Mid Term II, Quiz and Assignment, End Term, Mini Project |
| 25-29 | Process Heat integration: Concepts and basic principles of heat integration, Identification of area and cost targets, Pinch technology for heat exchanger network design | To synthesize the maximum energy recovery design of a given process | Lecture & Case study | 1705.3 | Mid Term II, Assignment & End term |
| 30-32 | Economic Decision making: Case study of gas absorber | To apply the concepts of process design in a case study & design absorber-stripper flowsheet | Lecture & case study | 1705.2 | Mid Term II & End Term |
| 33-37 | Cost Diagram & quick screening of process alternatives: General concepts and principles, Lumped cost diagram and cost allocation diagram, Case study of HDA | To acquaint the basic knowledge of process economics concepts | Lecture | 1705.1 | Quiz & End Term |
| 38-42 | Chemical Project economics: Selection of project site, project cost estimation, cost model and depreciation, time value of money, measures of profitability, project evaluation, tutorial | To investigate the profitability of a chemical project | Lecture & Tutorial | 1705.1 | Assignment, Project & End term |
| 43 | Simulations: Concept of process simulation, Introduction to aspen plus simulation | To design entire process flow sheet using a commercial flow sheeting software | Flipped Classroom & Activity | 1705.4 | Mini Project |

**L. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1705.1 | Understand concepts of process design and economics | 3 | 3 | 3 | 2 | 2 | 3 | 2 | | | | | 2 | 3 | 3 | 1 |
| CE 1705.2 | Analyse, synthesise and design processes for manufacturing products commercially | 3 | 3 | 3 | 2 | 1 | 2 | 3 | | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| CE 1705.3 | Develop skills in designing equipment optimally based on economics and process considerations | 2 | 2 | 2 | 2 | 2 | 2 | 3 | | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| CE 1705.4 | Use commercial flow sheeting software to simulate processes and design process equipment for enhancing employability in industries/consultancy firms | 1 | 2 | 1 | 1 | 1 | 2 | 3 | | | 2 | 2 | | 3 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering
Department of Chemical Engineering
Course Hand-out
Chemical Process Industries | CE 1706 | 3 Credits | 3 0 0 3
Session: July 30 – Nov 27, 2019 | Faculty: Dr. Harsh Pandey | Class: Core Course

A. **Introduction:** This course is offered by Dept. of Chemical Engineering as a core course. This course will cover the manufacturing of various chemicals and industrial gases related to chemical industry, which is an integral part of chemical sciences and engineering. Every chemical engineer should have knowledge on this content. It mainly covers the synthesis, industrial manufacture, process flow diagrams, properties and uses of various chemicals and industrial gases.

B. **Course Outcomes:** At the end of the course, students will be able to

**[CE1706.1].** Identify different types of chemical process industries classified as inorganic, organic and natural product industries and their applications.
**[CE 1706.2].** Recall various unit operation techniques and their use to synthesize a particular chemical.
**[CE 1706.3].** Understand the process flow diagram and various process parameters for the manufacture of various inorganic, organic and natural chemicals.
**[CE 1706.4].** Recognize and solve engineering problems during production, while also developing entrepreneurship skills along relevant lines.
**[CE 1706.5].** Interpret and illustrate the material balance involved in process synthesis.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Outcomes for B.Tech. in chemical engineering are as follows.

The Graduates of Chemical Engineering from MUJ will have:

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**[PSO.2]. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

D. **Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 20 |
| | Sessional Exam II (Close Book) | 20 |
| | In class Quizzes, Assignments, Presentation and Mini project | 30 |
| End Term Exam (Summative) | End Term Exam (Close Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Student who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

**E. SYLLABUS**

Overview of typical chemical processes, unit operations and unit processes, Indian chemical process industries scenario. Study aspects of chemical process industries - raw materials, consumption pattern, chemical reactions, process and block flow diagram, applications and major engineering issues. Uses of industrie 1s for Water conditioning and environmental protection.

**F. TEXT BOOKS**

1. "*Dryden's Outlines of Chemical Technology – for the 21st Century (3rd Edition)*", M Gopala Rao and Marshall Sitting, East-West Press, New Delhi (India), 1997.
2. "*Shreve's Chemical Process Industries (5th Edition)*", George T Austin, Tata McGraw-Hill Companies Inc, New York, 2012.

G. **REFERENCE BOOKS**

1. *"Unit processes in organic synthesis (5th ed)*", Groggins P H, Mcgraw-Hill, 2004.

**H. Lecture Plan:**

| Lecture | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode Of Assessing CO |
|---|---|---|---|---|---|
| 1 | **Introduction to chemical industries – Facts and figures** | Introduction to chemical industries. | Lecture | 1706.1 | Mid Term I, Assignment & End Term |
| 2 | **Unit operations and unit process concepts** | Introduce concepts of UOPs. | Lecture | 1706.2 | Mid Term I, Assignment & End Term |
| 3, 4, 5, 6 | **Sulfur and Sulfuric acid** | Mining of sulfur, Manufacture of sulfuric acid by contact and DCDA process, its applications, Engineering problems | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | Mid Term I, Assignment & End Term |
| 7, 8, 9, 10, 11 | **Fuels and Industrial gases** | Gases like producer gas, water gas, coke oven gas, natural gas, synthesis gas, hydrogen and acetylene. Different types of gasifiers | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | Mid Term I, Assignment & End Term |
| 12, 13, 14, 15, 16, 17 | **Fertilizer Industry** | Overview of fertilizer, major components of fertilizers.<br>Nitrogen fertilizers – ammonia, nitric acid, urea, ammonium nitrate.<br>Phosphate fertilizers – phosphoric acid, single and triple superphosphate, ammonium phosphate | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | Mid Term II, Assignment & End Term |
| 18,19 | **Cement Industry** | History and overview, scenario in India Portland cement and quick lime | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | Mid Term II, Assignment & End Term |
| 20, 21 | **Chlor-alkali industry** | Manufacturing of soda ash, caustic soda and chlorine by methods of production | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | Mid Term II, Assignment & End Term |
| 22, 23 | **Pulp and Paper Industry** | Kraft process and paper making process | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | Mid Term II, Assignment & End Term |
| 24, 25, 26, 27, 28, 29, 30, 31, 32, 33 | **SYNTHETIC ORGANIC CHEMICAL INDUSTRIES** | Few selected chemicals from C1, C2, C3 and C4 compounds<br>(***power point presentations by students***) | Student In-Class Presentations | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | Mid Term II, Assignment & End Term |

| | | | | | |
|---|---|---|---|---|---|
| 34 | **Pyrolysis and Cracking** | Pyrolysis and Cracking | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | Mid Term II, Assignment & End Term |
| 35, 36 | **Carbohydrates and fermentation industries** | Manufacturing of sugar or sucrose, ethanol production by fermentation | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | End Term |
| 37, 38 | **Edible and essential oils** | Extraction of vegetable oils, hydrogenation of oils | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | End Term |
| 39, 40, 41, 42 | **Soaps, Detergents and Glycerine** | Manufacturing of soaps, detergents and glycerine | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | End Term |
| 43, 44 | **Water conditioning and environmental protection** | Water conditioning and environmental protection | Lecture | 1706.1, 1706.2, 1706.3, 1706.4, 1706.5 | End Term |

## I. COURSE ARTICULATION MATRIX (Matching COs with POs):

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE1706.1 | Identify different types of chemical process industries classified as inorganic, organic and natural product industries and their applications | 2 | 3 | | | 2 | | | 2 | 1 | 1 | 1 | | 1 | 1 | 1 |
| CE1706.2 | Recall various unit operation techniques and their use to synthesize a particular chemical | 3 | 2 | 1 | | 1 | | 2 | 2 | 2 | | 3 | | 1 | 2 | 1 |
| CE1706.3 | Understand the process flow diagram and various process parameters for the manufacture of various inorganic, organic and natural chemicals | 3 | 3 | | | 3 | | 2 | 3 | 2 | 1 | 2 | | 3 | 3 | 2 |
| CE1706.4 | Recognize and solve engineering problems during production, while also developing entrepreneurship skills along relevant lines. | 3 | 2 | | | 2 | | 2 | 1 | 1 | | 2 | | 2 | 3 | 2 |
| CE1706.5 | Interpret and illustrate the material balance involved in process synthesis | 3 | 3 | 1 | | | | | 2 | | | 2 | | 3 | 2 | 1 |

**1- Low Correlation, 2- Moderate Correlation, 3- Substantial Correlation**

School of Civil and Chemical Engineering

Department of Chemical Engineering

Course Hand-out

Process Dynamic and Control | CE1707 | 4 Credits | 3 0 2 4

Session: July 19 – November 19 | Faculty: Anees A. Y. Khan | Class: VII Semester

**Introduction:** This course introduces the behavior and control of dynamic chemical process systems. Subject covers modeling the static and dynamic behavior of processes; control strategies; design of feedback, feedforward, and other control structures; and applications to process equipments.

**A. Course outcome: At the end of the course, the students will be able to:**

**[1707.1]** Develop skills to solve simple linear differential equations using Laplace transforms

**[1707.2]** Develop skills to identify, formulate, and solve linear chemical process dynamics problems

**[1707.3]** Design a control system to meet desired needs for a given process and analyze stability of transfer functions.

**[1707.4]** Develop and analyze a feedback control schemes

**[1707.5]** Familiarize with advanced control strategies like cascade, smith predictor, feed forward control to implement in operating decisions.

**C. Program outcomes and program specific outcomes**

**[PO.1]. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

**[PO.2]. Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

**[PO.3]. Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

**[PO.4]. Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**[PO.5]. Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

**[PO.6]. The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

**[PO.7]. Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

**[PO.8]. Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

**[PO.9]. Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

**[PO.10]. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

**[PO.12]. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Degree Specific Outcomes for chemical engineering are as follows:

**PSO.1** Concept to Commissioning: The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant.

**PSO.2** Process Intensification: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3** Specialization: students will be specialized in the areas of petroleum, energy and environment related fields.

**D. Assessment Plan**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 15 |
| | Tutorials | 15 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

**E. Syllabus**

Introduction to process control, Laplace transforms. Linear Open-Loop Systems, First-Order Systems: Transfer function, transient response (step response, impulse response, and sinusoidal response), and response of first-order systems in series: non-interacting systems and interacting systems. Second-Order Systems: Transfer function, step response, impulse response, sinusoidal response, transportation lag. Linear Closed-Loop Systems. Control system: Components of a control system, block diagram, negative feedback and positive feedback, servo problem and regulator problem. Controller and final control

element: Mechanism of control valve and controller, transfer functions (P, PI, PD, PID), Example of a chemical-reactor control system.

**F. Textbooks:**

1. Process System Analysis and Control, 3rd ed., Donald R. Coughnowr, McGraw-Hill Inc., 2013.

**G. Reference Books:**

1. George Stephanopoulos, Chemical Process Control: An Introduction to Theory & Practice, Prentice -Hall of India Pvt. Ltd., New Delhi, 1993.
2. Duncan A. Mellichamp, Dale Seborg, Thomas F. Edgar, Process Dynamics and Control, John Wiley & Sons Inc, 3rd ed., 2010.

**H. Lecture plan**

| Class Number | Topics | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introductory concepts of control system | Understanding the basic concept of control system | Lecture and discussion | - | NA |
| 2,3 | Modeling tools for process dynamics | Develop skills to model simple system related to chemical processes | Lecture and interaction | CO 1 | In Class Quiz |
| 4,5 | Inversion by partial fractions | Develop skills to solve simple linear differential equations using Laplace transforms | Lecture and interaction | CO 1 | |
| 6-10 | Linear open loop systems. Firs order systems response to various forcing functions such as step, impulse, ramp and sinusoids. | Develop skills to identify, formulate, and solve linear chemical process dynamics problems | Lecture, interaction and Tutorials | CO 2 | In Class Quiz |

| | | | | | |
|---|---|---|---|---|---|
| 11 | Physical examples of first order system and linearization | Develop skills to identify, formulate, and solve linear chemical process dynamics problems | Lecture, interaction and Tutorials | CO 2 | 1st Sessional<br>ET Exam<br>Home Assignment |
| 12-14 | Response of first order systems in series. Interacting and non-interacting systems | Develop skills to identify, formulate, and solve linear chemical process dynamics problems | Lecture, interaction and Tutorials | CO 2 | 1st Sessional<br>ET Exam<br>Home Assignment |
| 15-17 | Higher order systems: Second order system and transportation lag | Develop skills to identify, formulate, and solve linear chemical process dynamics problems | Lecture, interaction and Tutorials | CO 2 | |
| | Mid term 1 (and revision) | | | | |
| 18-23 | Linear closed loop control systems: components of a control systems, development of block diagrams. Controllers and final control elements: mechanism, ideal transfer function | Design a control system to meet desired needs for a given process. | Lecture, interaction and Tutorials | CO 3 | In Class Quiz |
| 24-28 | Block diagram of a chemical reactor control system: Reactor transfer function, control valve, measuring | Design a control system to meet desired needs for a given process. | Lecture, interaction and Tutorials | CO 2, CO 3 | |

| | | | | | |
|---|---|---|---|---|---|
| | element, controller, controller transducer, transportation lag and block diagram. Closed loop transfer functions: | | | | II Sessional<br><br>ET Exam |
| 29-32 | Overall transfer functions for single and multiloop. Transient response of simple control systems: Proportional control for set-point change, load change. Proportional integral for set point change and load change, proportional control of system with measurement lag. Stability: Concept and definition of stability, stability criterion, Routh test for stability. Concept of root locus | Design a control system to meet desired needs for a given process and analyze stability of transfer functions. | Lecture, interaction and Tutorials | CO 2,<br>CO 3 | Home Assignment |
| | Mid-term break | | | | |
| 33-36 | Introduction to frequency response: Substitution rule, Bode diagram. Control design by frequency response: Tank temperature control system, The Bode stability criterion, Gain and phase margins, Zeigler-Nicholas Controller settings. | Skill to develop and analyze a feedback control schemes | Lecture, interaction and Tutorials | CO3<br>CO4 | In Class Quiz<br><br>II Sessional |
| 37-42 | Advanced control strategies: Cascade control, Feedforward control, Ratio control, Dead-time compensation, internal model control. | Familiarize with advanced control strategies like cascade, smith predictor, feed forward control to implement in operating decisions. | Lecture, interaction and Tutorials | CO5 | ET Exam<br><br>Home Assignment |

| | | | | | |
|---|---|---|---|---|---|
| | Control tuning and process identification.<br>Control valve: Control valve construction, valve sizing, characteristics and positioner | | | | |
| | Mid term 2 ( and revision) | | | | |
| 43-46 | Theoretical analysis of complex processes: Control of a steam jacketed kettle, dynamic response of a gas absorber, distributed parameter model. | Skill to develop and analyze a feedback control schemes | Lecture, interaction and Tutorials | CO3<br>CO4 | ET Exam<br><br>Home Assignment |
| 47-52 | State-space representation of physical systems.<br>Transfer function matrix and multivariable control | Skill to develop and analyze a feedback control schemes | Lecture, interaction and Tutorials | CO3<br>CO4 | Home Assignment |

## I. Course Articulation Matrix: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| **[1707.1]** | Solve simple linear differential equations using Laplace transforms | 3 | 2 | | | 3 | | | | | | | | 3 | | |
| **[1707.2]** | Identify, formulate, and solve linear chemical process dynamics problems | | 3 | 2 | | 3 | | | | | 1 | | 1 | 3 | | |
| **[1707.3]** | Design a control system to meet desired needs for a given process and analyze stability of transfer functions. | | 2 | 3 | | 3 | 1 | | | 2 | | | | 3 | | |
| **[1707.4]** | Develop and analyze a feedback control schemes | | | 2 | | 3 | | 1 | | | | | | 2 | | |
| **[1707.5]** | Familiarize with advanced control strategies like cascade, smith predictor, feed forward control to implement in operating decisions. | | | 3 | | 3 | | | | | | | | | 2 | |

**1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering
Department of Chemical Engineering
Course Hand-out
Engineering Economics and Project Management | CE 1708/02 | 3 Credits | 3 0 0 3
Session: Jul 19-Dec 19 | Faculty: Dr. Gaurav Kataria| Class: B. Tech.

**A. Introduction:** The business of business is making money – regardless of area and scale!

Economic evaluation of investment alternatives that maximize profits is a major goal of any corporate manager – or, even an individual. This requires familiarity with economic evaluation and investment decision methods to provide a sound quantitative basis to scrutinize choose the best among alternative engineering projects and general investment opportunities.

Economic feasibility is a pre-requisite for investing in any engineering or non-engineering investment opportunity.

**Project Management**

Managing projects for on – time completion is very necessary to avoid cost – overruns. Network techniques, such as CPM / PERT / others, are used to aid in planning, scheduling, monitoring and control of activities that are related to each other, and required, for completion of any project (engineering and non-engineering).

**Hence, the methods discussed in this course are equally valid for use by**

- Engineers
- Business Managers
- Bankers
- Accountants
- Individuals
- Others

**B. Course Outcomes:** At the end of the course, students will be able to:

**CE1708.1** Present and discuss the 'Economic Evaluation' fundamentals and Project Management techniques (Gantt Chart / Networks (CPM / PERT / Others).
**CE1708.2** 'Arm' the student with the methodology to evaluate project investment alternatives.
**CE1708.3** Develop the employability skills to manage projects and identify bottlenecks for better scheduling and control.
**CE1708.4** Develop employment / entrepreneurship skills for economic evaluation and investment decision methods / project management techniques.

**C. Program Outcomes**

Graduate attributes in the B.Tech. Course in Chemical Engineering include:

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## D. Program Specific Outcomes

**PSO.1. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**PSO.2. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## E. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | Quizzes and Home/Class Assignments (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who miss a class will not be provided with any sort of makeup assignment or make up quiz. If you miss a lecture, you yourself have to study the topics that were covered during that particular lecture. However, you may contact the course coordinator for clarification of doubts, if any. | |

## F. Syllabus

Cash Flow Concepts, Present Future and Annual Values, Net Present Value, Present value Ratio, Rate of Return, Breakeven, Depreciation and taxes, Project Definition, Project network, scheduling resource and cost, Managing project risk, Project progress, performance measurement, and evaluation.

## G. Text Books

T1. "Economic Evaluation and Investment Decision Methods (14tht Edition)", Franklin J Stermole and Johm M Stermole, Investment Evaluation Corporation, Golden,CO (USA), 2014.

T2. "Operations Research: An Introduction", Hamdy A Taha, Prentice Hall, 1997.

## H. Reference Books

R1. Peters M. S., Timmerhaus K. D., and West R. E., Plant Design and Economics for Chemical Engineers, McGraw Hill Higher Education, 5th Edition, 2003.

## I. Lecture Plan:

| Lecture No. | Topics | Session Outcome | Mode of Delivery | Corresponding Course Outcome | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1. | Introduction – Making Decisions / Concept of Interest / Minimum Rate of Return / Investment Analysis (1-13) | Understanding the basics of subject that why are they studying this in engineering. | Lecture | 1708.1 | Mid Term I<br>End Term |
| 2. | Compound Interest Formulae and Equivalence Applications (15-41) | Understanding the interest scenario in industries. | Lecture | 1708.1 | Mid Term I<br>End Term |
| 3. | Compound Interest Formulae and Equivalent Applications (42-52) | Understanding the interest scenario in industries. | Lecture | 1708.1 | Mid Term I<br>End Term |
| 4. | Present Worth / Annual Worth / Future Worth / ROR / Break-Even Analysis (64-91) | Relating the time with money | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 5. | Present Worth / Annual Worth / Future Worth / ROR / Break-Even Analysis (91-120) | Relating the time with money | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 6. | Present Worth / Annual Worth / Future Worth / ROR / Break-Even Analysis (120-157) | Relating the time with money | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 7. | Incremental Cost Analysis Methods – Mutually Exclusive Investment Analysis by ROR / Unequal Life Projects / NPV / Future Worth of Cash Flows (183-200) | Understanding how to compare the positive ROR alternative with the negative or infinite ROR alternative. | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 8. | Incremental Cost Analysis Methods – Mutually Exclusive Investment Analysis by ROR / Unequal Life Projects / NPV / Future Worth of Cash Flows (201-220) | Understanding how to compare the positive ROR alternative with the negative or infinite ROR alternative. | Lecture | 1708.2/4 | Mid Term I<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 9. | Incremental Cost Analysis Methods – Mutually Exclusive Investment Analysis by ROR / Unequal Life Projects / NPV / Future Worth of Cash Flows (220- 256) | Understanding how to compare the positive ROR alternative with the negative or infinite ROR alternative. | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 10. | Incremental Cost Analysis Methods – Mutually Exclusive Investment Analysis by ROR / Unequal Life Projects / NPV / Future Worth of Cash Flows (Handout) | Understanding how to compare the positive ROR alternative with the negative or infinite ROR alternative. | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 11. | Production Cost Variations / Break-Even Analysis / Min Cost/Max Profit Analysis (64 + Handout) | Understanding the concept of variable cost and fixed cost. | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 12. | Production Cost Variations / Break-Even Analysis / Min Cost/Max Profit Analysis (Handout) | Understanding the concept of variable cost and fixed cost | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 13. | Sensitivity Analysis / Inflation / Risk Analysis (276-306) | Understanding the sensitivity of the parameters relating to production and marketing. | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 14. | Sensitivity Analysis / Inflation / Risk Analysis (313-327) | Understanding the sensitivity of the parameters relating to production and marketing. | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 15. | Sensitivity Analysis / Inflation / Risk Analysis (327-351) | Understanding the sensitivity of the parameters relating to production and marketing. | Lecture | 1708.2/4 | Mid Term I<br>End Term |
| 16. | Review Lecture | Reviewing all the syllabus that has been completed. | Lecture | | Mid Term I<br>End Term |
| **MID-TERM I** | | | | | |
| 17. | Depreciation / Depletion / Amortization (359-366) | Understand the concept of decreasing value of tangible/non tangible things. | Lecture | 1708.2 | Mid Term II<br>End Term |
| 18. | Depreciation / Depletion / Amortization (366-384) | Understand the concept of decreasing value of tangible/non | Lecture | 1708.2 | Mid Term II<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| | | tangible things. | | | |
| 19. | Depreciation / Depletion / Amortization (384-403) | Understand the concept of decreasing value of tangible/non tangible things. | Lecture | 1708.2 | Mid Term II<br>End Term |
| 20. | Income Tax, Cash Flow, and Discounted Cash Flow Rate of Return (415-435) | Understanding what to include or exclude from the income to save income tax. | Lecture | 1708.2/4 | Mid Term II<br>End Term |
| 21. | Income Tax, Cash Flow, and Discounted Cash Flow Rate of Return (435-470) | Understanding what to include or exclude from the income to save income tax. | Lecture | 1708.2/4 | Mid Term II<br>End Term |
| 22. | After-Tax Investment Decision Methods and Applications (487-521) | Understand how to estimate the after tax or actual ROR. | Lecture | 1708.2/4 | Mid Term II<br>End Term |
| 23. | After-Tax Investment Decision Methods and Applications (521-548) | Understand how to estimate the after tax or actual ROR. | Lecture | 1708.2/4 | Mid Term II<br>End Term |
| 24. | Replacement Analysis (567-593) | Understand the alternatives of replacing the machinery or other things. | Lecture | 1708.2/4 | Mid Term II<br>End Term |
| 25. | Replacement Analysis (594-605) | Understand the alternatives of replacing the machinery or other things. | Lecture | 1708.2/4 | Mid Term II<br>End Term |
| 26. | Leverage Concepts: Evaluations Involving Borrowed Money (616-639) | Compare the alternatives of taking leverage of paying at one go. | Lecture | 1708.2/4 | Mid Term II<br>End Term |
| 27. | Leverage Concepts: Evaluations Involving Borrowed Money (639-647) | Compare the alternatives of taking leverage of paying at one go. | Lecture | 1708.2/4 | Mid Term II<br>End Term |
| 28. | Review Lecture | Reviewing all the syllabus that has been completed after Mid Term I. | Lecture | | Mid Term II<br>End Term |
| **MID-TERM II** | | | | | |
| 29. | Introduction to Project Management and Control | Understand the necessity to study project management in chemical | Lecture | 1708.1/3 | End Term |

| | | | | | |
|---|---|---|---|---|---|
| | | engineering. | | | |
| 30. | Gantt Chart | Understanding how to schedule the project | Lecture | 1708.1/3 | End Term |
| 31. | Introduction to Networks – Terminology (Handout) | Understanding how to distinguish critical and non critical activities. | Lecture | 1708.1/3 | End Term |
| 32. | Critical Path Method (CPM) (278-288 + Handout) | Understand how to evaluate the critical path which will not to be violated. | Lecture | 1708.1/3 | End Term |
| 33. | Project Evaluation and Review Technique (PERT) (288-290 + Handout) | If the project is working on probabilistic timeline than understanding how to evaluate the probability that project will complete in the pre described time. | Lecture | 1708.1/3 | End Term |
| 34. | PERT (Handout) | If the project is working on probabilistic timeline than understanding how to evaluate the probability that project will complete in the pre described time. | Lecture | 1708.1/3 | End Term |
| 35. | Other Topics in Networks – Shortest Route Problem | If the project is working on probabilistic timeline than understanding how to evaluate the probability that project will complete in the pre described time. | Lecture | 1708.1/3 | End Term |
| 36. | Review | Reviewing all the syllabus that has been completed. | Lecture | | End Term |
| **END-TERM EXAMINATION** | | | | | |

**T3. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE1708.1 | Present and discuss the 'Economic Evaluation' fundamentals and Project Management techniques (Gantt Chart / Networks (CPM / PERT / Others). | | 1 | | 1 | | | | 1 | 1 | 2 | 3 | | 1 | 2 | |
| CE1708.2 | 'Arm' the student with the methodology to evaluate project investment alternatives. | | 2 | 1 | 1 | | | | 2 | 1 | 2 | 3 | | 1 | 2 | |
| CE1708.3 | Develop the employability skills to manage projects and identify bottlenecks for better scheduling and control. | | 2 | 1 | 1 | | | | 2 | 1 | 2 | 3 | | 1 | 2 | |
| CE1708.4 | Develop employment / entrepreneurship skills for economic evaluation and investment decision methods / project management techniques. | | 2 | 1 | 1 | | | | 2 | 1 | 2 | 3 | | 1 | 2 | |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Petrochemical Production Technologies | CE 1753 | 3 Credits | 3 0 0 3

Session: Aug 19 – Dec 19 | Faculty: Anand Chakinala | Class: Program Elective

**A. Introduction:** This course on petrochemical production technologies is a program elective designed for the undergraduate students of Chemical Engineering. This course introduces the basic overview of petrochemical technologies and discuss upon the general topology of the process technologies.

**B. Course Outcomes:** At the end of the course, students will be able to

**[1753.1].** Discuss the major petrochemicals produced and their economic importance

**[1753.2].** Explain the major components of petrochemical plants and come up with alternative routes of production that will enhance their employability as well as entrepreneurship skills.

**[1753.3].** Discuss the production processes of C2, C3, C4 and aromatic derived petrochemicals

**[1753.4].** Understanding the safety precautions in petrochemical processes

**C. Program outcomes and program specific outcomes**

Program Outcomes for B.Tech. in chemical engineering are as follows.

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**[PSO.2]. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | In class Quizzes, Assignments, Projects, Case Studies (Accumulated and Averaged) | 30 |
| End Term Exam | End Term Exam (Open Book) | 30 |
| | Total | 100 |
| Attendance | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments | No make-up for missed short quizzes/assignments or exam will be allowed except in extenuating circumstances, with prior permission of the instructor(s), and the decision of the instructor(s) in this regard shall be final. | |
| Homework/ Home Assignment/ Project | Home works will be assigned in between the lectures along with the due date for handing it over. No late assignments handed after the due date shall be accepted under any circumstance. It is expected that the students shall work on the assignments independently and not 'copy' the solutions from each other. A case study is given which is assessed in form of individual reports submitted. | |

**E. Syllabus**

**Introduction** – Petrochemical industry-Structures of petrochemical complexes-Feedstock for petrochemical-Profile of petrochemical and their end products; **Olefins production:** Steam cracking for production of olefins-Gas sweetening unit-C2/C3 Extraction unit-Steam cracking process engineering and technology-Emerging technologies for production of olefins- Alpha Olefins; **Olefin Production:** Steam cracking for production of olefins-Gas sweetening unit-C2/C3 Extraction unit-Steam cracking process engineering and technology-Emerging technologies for production of olefins-Alpha Olefins; **Methane and synthesis gas derivatives:** Synthesis gas and ammonia-synthesis gas and ammonia manufacture from steam reforming-Synthesis gas and ammonia manufacture from partial oxidation process-Urea processes, Process technology-Carbon monoxide-Fischer-Tropsch syn gas technology-Methanol-Formaldehyde-Acetic acid - Chloromethanes - Dimethyl formamide - Dimethyl acetamide - Acetylene; **Ethylene and ethylene derivatives-I:** Ethylene-Ethylene oxide-Process technology-Process hazards-Ethylene oxide storage-Monoethylene glycol-Vinyl chloride-Vinyl acetate-Acetaldehyde-Ethanol-Acetic anhydride-Ethyl acetate-Ethyl chloride; **Aromatic production:** Petroleum feedstock for aromatic hydrocarbons-Aromatic hydrocarbon production catalytic reforming-Reactions in catalytic reforming-Reforming catalyst-Reforming process-Process variables in catalytic reforming-Pyrolysis gasoline as aromatics feedstock-Aromatic separation from reformate and pyrolysis gasoline- technologies for the production of BTX- Aromatic conversion processes; **Oxo Process**

**F. Text books**


**1)** Sami Matar and Lewis F.Hatch, Chemistry of Petrochemical Processes, 2nd Edition, Gulf Publishing Company, Houston, 2000.

**2)** B. K. Bhaskara Rao, Petrochemicals, Oxford & IBH Publishing, 2002.


**G. Reference books**


**1)** I.D. Mall, Petrochemical Process Technology, Macmillan India Ltd., New Delhi. 2007.

**2)** P. Belov, Fundamentals of Petroleum Chemical Technology, Mir Publishers, 1970.

**3)** A. Chauvel and G.Lefebvre, Petrochemical Processes, Volume 1 & 2, Gulf Publishing Company, 1989.

**4)** Robert A. Meyers, Handbook of Petrochemical Production Processes, McGraw-Hill, 2004.

**Lecture Plan:**

| LEC NO | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode of assessing CO |
|---|---|---|---|---|---|
| 1 – 2 | Introduction to petrochemical industry | To acquaint with the chemicals derived from crude | Lecture | 1753.1 | Mid Term - 1, End Term, |
| 3 – 7 | Olefin production | To understand the production of olefins in a refinery | Lecture | 1753.2, 1753.4 | Mid Term - 1, End Term, |
| 8 – 12 | $C_1$ compounds: Methane and syngas derivatives | To familiarize with production processes/technologies of C1 compounds | Lecture | 1753.3, 1753.4 | Mid Term - 1, End Term, Assignment |
| 13 – 17 | $C_2$ compounds: Ethylene and its derivatives | To familiarize with production processes/technologies of C2 compounds | Lecture | 1753.3, 1753.4 | Mid Term - 1, End Term, Assignment |
| 18 – 23 | $C_3$ compounds: Propylene and its derivatives | To familiarize with production processes/technologies of C3 compounds | Lecture | 1753.3, 1753.4 | Mid Term - 1, End Term, Assignment |
| 24 – 29 | $C_4$ compounds: Butanes and Butenes | To familiarize with production processes/technologies of C4 compounds | Lecture | 1753.3, 1753.4 | Mid Term - 1, End Term, Assignment |
| 30 – 33 | Aromatic compounds: Benzene | To gain the knowledge of production of aromatics in a refinery | Lecture | 1753.3, 1753.4 | Mid Term - 1, End Term, Assignment |
| 33 – 36 | Oxo process/Hydroformylation | To gain knowledge of higher alcohol production. | Lecture | 1753.3, 1753.4 | Mid Term - 2, End Term |

**H. Course Articulation Matrix: (Mapping of COs with POs)**

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | *PSO1* | *PSO2* | *PSO3* |
| CE1753.1 | Discuss the major petrochemicals produced and their economic importance | 1 | 1 | | | | | | | | | | | 1 | | 2 |
| CE1753.2 | Explain the major components of petrochemical plants | 1 | 1 | 2 | 1 | | 1 | 1 | | | | | 1 | | | 2 |
| CE1753.3 | Discuss the production processes of C2, C3, C4 and aromatic derived petrochemicals | 2 | 1 | 2 | 1 | | 1 | 1 | | | | | 1 | 1 | 1 | 2 |
| CE1753.4 | Understanding the safety precautions in petrochemical processes | 1 | 1 | | | | 3 | 2 | 1 | | | | 1 | | | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering

Department of Chemical Engineering
Course Hand-out

Energy and Process Integration | CE 1754 | 3 Credits | 3 0 0 3

Session: July'19 – Nov'19 | Faculty: Dr. Abhishek Sharma | Class: B. Tech. (Chemical) VII Semester

## A. Introduction:

Integration is the process of keeping 'all together' in an optimized way. Chemical process needs to be integrated in an optimized way so that the whole process requires minimum energy as well as the cost. Therefore, we have to be familiar with the fundamental concepts related to process integration, pinch technology, heat exchanger network and energy targeting. The contents discussed in this course will be useful for a chemical engineer working in process & plant design as well as research & development.

## B. Course Outcomes: At the end of the course, students will be able to

**[1754.1].** Understand the fundamentals of process integration and pinch technology.
**[1754.2].** Carry out pinch analysis for heat exchanger networks using chemical engineering skills.
**[1754.3].** Identify the energy target, unit target, area target, cost target and supertargeting for a heat exchanger network (HEN).
**[1754.4].** Recognize maximum energy recovery (MER) network using pinch design method (PDM).
**[1754.5].** Conduct the process optimization of energy and resource analysis using network evolution and evaluation.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Outcomes for B.Tech. in chemical engineering are as follows.

The Graduates of Chemical Engineering from MUJ will have:

**[PO.1]. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
**[PO.2]. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
**[PO.3]. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
**[PO.4]. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
**[PO.5]. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
**[PO.6]. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
**[PO.7]. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
**[PO.8]. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
**[PO.9]. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
**[PO.10]. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
**[PO.11]. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
**[PO.12]. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**[PSO.1]. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**[PSO.2]. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**[PSO.3]. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 20 |
| | Sessional Exam II (Open Book) | 20 |
| | Project, Quizzes/Assignments (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester. | |
| Homework/ Home Assignment/ Activity Assignment (Formative) | There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. | |

## E. SYLLABUS

Introduction – Energy Targeting and the Pinch Principle, Problem Table, Cascade Diagram, Composite / Grand Composite Curves, Pinch Point, Utility Pinch; Maximum Energy Recovery Network – Pinch Design Method, Grid\Diagram, Stream Splitting / Matching; Evolution / Evaluation of Networks – Euler's Principle, Identification and Breaking of Loops Using Paths; Capital Cost targeting, Continuous Targeting – Area / Cost Targeting, Vertical Heat Transfer, Threshold Problem, Super targeting; Distillation Column Targeting Principles, Grand Column Composite Curves, Column Composite Curves, Evaluation of Energy Saving Options; Introduction to Heat and Power Systems.

## F. BOOKS


1. Shenoy, U.V., *Heat exchanger network synthesis: Process optimization by energy and resource analysis*, Gulf publishing, 1995.
2. Douglas, James. M., *Conceptual design of chemical processes*, McGraw-Hill Inc, 1988.
3. Seider, W. D., Seader, J. D., Lewin, D. R., Widagdo, S., *Product and process design principles: synthesis, analysis and evaluation (3rd Ed)*, John Wiley & Sons, Singapore, 2010.
4. Kemp, I. C., *Pinch analysis and process integration: A user guide on process integration for the efficient use of energy*, Butterworth Heinemann, 2006.
5. Klemes, J. J., Varbanov, P. S., Alwi S. R. W. W., and Manan, Z. A., *Process Integration and Intensification: Saving Energy, Water and Resources*, De Gruyter, 2014.

**Lecture Plan:**

| Lecture | TOPICS | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing CO |
|---|---|---|---|---|---|
| 1 | Introduction and course hand-out briefing | Acquainted with basics of Energy and Process Integration | Lecture | 1754.1 | Mid Term I, Quiz/Assignment/Project & End Term |
| 2 | Process integration, methods and area of application, history and few examples from nature | Acquainted with basics of Energy and Process Integration | Lecture | 1754.1 | Mid Term I, Quiz/Assignment/Project & End Term |
| 3 | Fundamentals concepts related to heat integration (process design hierarchy, onion diagram), energy losses by various industries, The role of thermodynamics in process design | Acquainted with basics of Energy and Process Integration | Lecture | 1754.1 | Mid Term I, Quiz/Assignment/Project & End Term |
| 4 | Key concepts of process integration and pinch analysis and its significance, Composite curves (basic concepts of heat exchange and temp–enthalpy diagram) | Understanding the fundamentals of Energy Exchange in Process | Lecture | 1754.2 | Mid Term I, Quiz/Assignment/Project & End Term |
| 5 | Hot and cold composite curves and their allowability of shifting vertically/horizontally | Understanding the fundamentals of Energy Exchange in Process | Lecture | 1754.2 | Mid Term I, Quiz/Assignment/Project & End Term |
| 6 | Network grid representation | Understanding the fundamentals of Energy Exchange in Process | Lecture | 1754.2 | Mid Term I, Quiz/Assignment/Project & End Term |
| 7 | Temperature intervals and heat cascade diagram | Understanding the fundamentals of Energy Exchange in Process | Lecture | 1754.2 | Mid Term I, Quiz/Assignment/Project & End Term |
| 8, 9, 10 | Energy targeting procedure (problem table algorithm, pinch point and minimum utility requirements) | Understanding the fundamentals of Energy Exchange in Process | Lecture | 1754.2 | Mid Term I, Quiz/Assignment/Project & End Term |
| 11 | Basic pinch design method (understanding the pinch design feasibility and important design criteria), maximum energy recovery (MER) network | Acquiring the Design knowledge of HEN in Process | Lecture | 1754.3 | Mid Term I, Quiz/Assignment/Project & End Term |
| 12, 13, 14 | Case study – MER network drawing (split and without split network), stream split algorithm | Acquiring the Design knowledge of HEN in Process | Lecture | 1754.3 | Mid Term I, Quiz/Assignment/Project & End Term |

| | | | | | |
|---|---|---|---|---|---|
| 15, 16 | Concept of balanced composite curves | Acquiring the Design knowledge of HEN in Process | Lecture | 1754.3 | Mid Term II, Quiz/Assignment/Project & End Term |
| 17 | Concept of grand composite curves and use of multiple utilities | Acquiring the Design knowledge of HEN in Process | Lecture | 1754.3 | Mid Term II, Quiz/Assignment/Project & End Term |
| 18 | Concept of vertical heat transfer and Spaghetti network | Acquiring the Design knowledge of HEN in Process | Lecture | 1754.3 | Mid Term II, Quiz/Assignment/Project & End Term |
| 19 | Case Study – number of units targeting | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 20 | Euler's network and graph theory for number of units and loop finding. Concept of loops and paths. | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 21, 22 | Identification of loops, elimination of loop | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 23 | Checking $\Delta$Tmin violation and restoration by path relaxation | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 24, 25 | Network evolution and evaluation and final MER design after path relaxation | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 26 | Case Study – shell targeting | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 27 | Case Study – cost targeting (operating cost, capital cost and total annual cost) | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 28 | Effect of $\Delta$Tmin and supertargeting | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 29 | Fundamentals of threshold problems and pseudo pinch problems | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 30 | Case study – threshold problem | Grasping the basics of advanced HEN | Lecture | 1754.4 | Mid Term II, Quiz/Assignment/Project & End Term |
| 31 | Continuous targeting and determination of significant curve shift | Developing the knowledge of solving HEN problems in Industries | Lecture | 1754.5 | Quiz/Assignment/Project & End Term |

| | | | | | |
|---|---|---|---|---|---|
| 32 | Case study – continuous determination of energy and unit targets | Developing the knowledge of solving HEN problems in Industries | Lecture | 1754.5 | Quiz/Assignment/Project & End Term |
| 33 | Topology trap | Developing the knowledge of solving HEN problems in Industries | Lecture | 1754.5 | Quiz/Assignment/Project & End Term |
| 34 | Fast matching algorithm for threshold problem | Developing the knowledge of solving HEN problems in Industries | Lecture | 1754.5 | Quiz/Assignment/Project & End Term |
| 35 | Retrofitting of final network | Developing the knowledge of solving HEN problems in Industries | Lecture | 1754.5 | Quiz/Assignment/Project & End Term |
| 36 | Basic concepts of designing of multi-pinch problems | Developing the knowledge of solving HEN problems in Industries | Lecture | 1754.5 | Quiz/Assignment/Project & End Term |
| | | | | | |

## G. Course Articulation Matrix: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE 1754.1 | Understand the fundamentals of process integration and pinch technology | 2 | 2 | 1 | | | 2 | 3 | 1 | | 1 | | | 1 | 2 | 3 |
| CE 1754.2 | Carry out pinch analysis for heat exchanger network network using chemical engineering skills | 3 | 3 | 3 | 3 | | 2 | 3 | 1 | 1 | 2 | | 1 | 2 | 3 | 3 |
| CE 1754.3 | Identify the energy target, unit target, area target, cost target and supertargeting for a heat exchanger network | 3 | 3 | 3 | 3 | | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 3 | 3 | 3 |
| CE 1754.4 | Recognize maximum energy recovery (MER) network using pinch design method | 2 | 3 | 3 | 3 | | 2 | 2 | | | 2 | 2 | 1 | 2 | 2 | 3 |
| CE 1754.5 | Conduct the process optimization of energy and resource analysis using network evolution and evaluation | 2 | 3 | 3 | 3 | | 2 | 3 | | 1 | 2 | 2 | 2 | 2 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# MANIPAL UNIVERSITY JAIPUR

School of Civil and Chemical Engineering
Department of Chemical Engineering
Course Hand-out
Process Intensification | CE 1803/1801 | 3/4 Credits | 3/3 0/1 0/0 3/4
Session: Jan 20 – May 20| Faculty: Dr Gaurav Kataria| Class: VIII Semester

## A. COURSE SUMMARY:

In the modern times, there has been a great focus on the optimal use of energy and cost to get better way of life. However, the chemical and process industry has a delayed response in incorporation of new technologies, because of the high risk involved. In the 1980's, Colin Ramshaw introduced to the world the idea of high gravity (HiGEE) based distillation and paved the way for what is today *Process Intensification*. This topic covers a wide range of unit operations and unit processes that have been reimagined to become highly optimized and efficient. The current course has been designed to introduce to the students the idea of process intensification and give them a feel of its application to unit operations and unit processes.

## B. COURSE OUTCOME:

By the end of the course the students will be able to

CE1803.1. Describe the basic principles underlying process intensification.
CE1803.2. Describe with elaboration the design of different physical process intensification equipment.
CE1803.3. Assess the enhancement factors responsible for heat intensification in process industries and their applications.
CE1803.4. Develop skills to assess the design of intensified reactors for different types of reactions.
CE1803.5. Develop skills to assess the enhancement factors responsible for intensification of separation processes related to equipment design and application.

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Graduate attributes in the B.Tech. Course in Chemical Engineering include:

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes for chemical engineering are as follows:

**PSO.1. Concept to Commissioning:** The students of the program would be able to envision, synthesize, demonstrate, and design any chemical processes right from conceiving the idea to commissioning of a full scale plant taking into account environmental concerns.

**PSO.2. Process Intensification**: Graduates would be equipped with the skills of assessing and finding cost effective innovations involving process intensification and integration for sustainable future developments.

**PSO.3. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 20 |
| | Sessional Exam II (Closed Book) | 20 |
| | Quizzes and Home/Class Assignments (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |

| | |
|---|---|
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. |
| Make up Assignments (Formative) | Students who miss a class will not be provided with any sort of makeup assignment or make up quiz. If you miss a lecture, you yourself have to study the topics that were covered during that particular lecture. However, you may contact the course coordinator for clarification of doubts, if any. |

## E. SYLLABUS:

Introduction to process intensification (PI): sustainability related issues in process industry; definitions of process intensification; fundamental principles and approaches of PI; design of a sustainable and inherent safer processing plants.

Mechanisms involved in PI: intensified heat transfer, intensified mass transfer, electrically enhanced processes, micro fluidics; compact and micro heat exchangers;

Reactors: Reactor engineering theory, spinning disc reactors, oscillatory baffled reactors, micro reactors, reactive separations, membrane reactors, supercritical operations, Field enhanced reactors, Rotating fluidized beds

Intensification and separation processes: Distillation (reactive, extractive), centrifuges, membranes, drying, precipitation and crystallization; Intensified mixers, PI case study.

## F. TEXT BOOKS:

T1. Reay, D.A.; Ramshaw, C.; Harvey, A.P.; "*Process Intensification: engineering for efficiency, sustainability and flexibility*", 1ed, (IChemE) Butterworth Harriman, London, 2008.

T2. Stankiewicz, A.; Moulijn, J.A.; (Eds) "*Re-Engineering the Chemical Processing Plant: Process Intensification*," 1st ed., CRC Press, 2003.

## G. REFERENCE BOOKS:

R1. Segovia-Hernandez, J.G.; Bonilla-Petriciolet, A.; (Eds) "*Process Intensification in Chemical Engineering Design Optimization and Control*", 1st ed., Springer, 2016.

R2. Keil, F.J.; (Ed) "*Modelling of Process Intensification*", 1st ed., Wiley International, 2007.

R3. Kiss, A.A; "*Process Intensification Technologies for Biodiesel Production*", 1st ed., Springer, 2014.

R4. Raghavan, K.V; Reddy, B.M.; (Eds) "*Industrial Catalysis and Separations Innovations for Process Intensification*", 1st ed, CRC Press/Apple Academic Press, 2015.

R5. Mothes, H.; "*Process Design Synthesis, Intensification and Integration of Chemical Processes*", 1st ed, Manufective, 2015.

## H. LECTURE PLAN:

| Lectures | Content | Session Outcome | Mode of Delivery | CO tracking | Assessment |
|---|---|---|---|---|---|
| 1-3 | Introduction to Process Intensification (PI) | Understand the basics and history of Process intensification, unit operation and unit processes, philosophy and opportunity of PI, classification of PI, sustainability of PI | Lecture | CE1803.1 | Class Quiz |
| 4-6 | Physical methods for PI | Understand the use of Momentum transfer concepts Mixing and flow through packed bed, channel flow, and fluidization, static mixers, spinning disk, oscillatory baffled mixers in PI. | Lecture | CE1803.2 CE1803.5 | Class Quiz, Case study essay, Mid Semester exams. |
| 7-14 | PI for heat transfer | Understand the use of Heat transfer operations, combined heat and fluid flow, intensification of heat flow, plate heat exchangers, spiral heat exchangers, plate and shell heat exchangers, plate fin heat exchangers, flat tube and fin heat exchangers, microchannel heat exchangers, Matrix heat exchangers, application of heat exchangers, nanofluids in PI. | Lecture | CE1803.2 CE1803.3 CE1803.5 | Class quiz, Case study essay, mid semester exam and end semester exam |
| Mid Term I | | | | | |
| 15-22 | PI for separation processes | Understand the use of mass transfer concepts, nanofluids, divided walls columns, HiGee distillation, centrifuges, membranes, drying, crystallization, Soxhlet extraction, ultrasound mass transfer in PI. | Lecture | CE1803.5 CE1803.1 | Class quiz, case study essay, mid and end semester exams |
| 23-34 | PI for reactions and reactors. | Understand the concept of mass transfer with chemical reactions, reactive distillation, reactive adsorption, reactive extraction, supercritical fluids, spinning reactors, ultrasound reactors, cavitation reactors, HEX reactors, Fluidized bed reactors, packed bed reactors, membrane reactors used to intensify the Processes in chemical engineering. | Lecture | CE1803.4 CE1803.5 CE1803.1 | Class quiz, case study essay, mid and end semester exams |
| Mid Term II | | | | | |
| 35-40 | Application of PI | Follow the case studies of how PI can be applied for all different process industries. | Lecture | CE1803.2 CE 1803.3 CE1803.4 CE1803.5 | Class quiz, case study essay, mid and end semester exams |
| End Term | | | | | |

## I. COURSE ARTICULATION MATRIX (Matching COs with POs):

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CE1803.1 | Describe the basic principles underlying process intensification. | 3 | 2 | | | 2 | | | 1 | 2 | | 1 | | 1 | 3 | |
| CE1803.2 | Describe with elaboration, design of different physical process intensification equipment. | 1 | 2 | | | 1 | | | 1 | 2 | | | 1 | 1 | 3 | |
| CE1803.3 | Assess the enhancement factors responsible for heat intensification in process industries and their applications. | 1 | 2 | | | 1 | | | 1 | 2 | | | 1 | | 3 | 1 |
| CE1803.4 | Develop skills to assess the design of intensified reactors for different types of reactions. | 1 | 2 | | | 1 | | | 1 | 2 | | | 1 | | 3 | 1 |
| CE1803.5 | Develop skills to assess the enhancement factors responsible for intensification of separation processes related to equipment design and application. | 1 | 2 | | | 1 | | | 1 | 2 | | | 1 | | 3 | 1 |

**1- Low Correlation, 2- Moderate Correlation, 3- High Correlation**

**MANIPAL UNIVERSITY JAIPUR**
School of Civil and Chemical Engineering
Department of Chemical Engineering
Course Handout
Process Optimization | CE1804 | 3 Credits | 3 0 0 3
Session: Jan'20 – May'20 | Faculty: Dr. Manisha Sharma | Class: B. Tech. (Chemical)
VIII Semester

## A. INTRODUCTION

Due to the increased cost of energy and stringent environmental regulations, the chemical industry has gone through several developments during the past few years. Optimization is one of the tools to address these issues. With an emphasis on problem formulation, this course introduces the students to the basic concepts of Optimization which has been applied in many fields of science, engineering, as well as business. The various techniques and tools used for optimization have also been discussed in this course.

## B. COURSE OUTCOMES

At the end of the course, students will be able to:

| | |
|---|---|
| **[CE1804.1]** | Develop a mathematical statement for the objective function and the equality and inequality constraints |
| **[CE1804.2]** | Implement the theory and applications of optimization techniques in a comprehensive manner for solving linear and non-linear, geometric, dynamic, integer and stochastic programming techniques |
| **[CE1804.3]** | Identify, formulate and solve a practical engineering problem of their interest by applying or modifying an optimization technique to enhance employability skills |
| **[CE1804.4]** | Use of commercial software to optimize chemical processes thereby enhancing their skills. |

## C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

The Graduates of Chemical Engineering from MUJ will have:

**PO1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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**PSO.3. Specialization:** Students will be specialized in the areas of petroleum, energy and environment related fields.

## D. ASSESSMENT PLAN

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|---|---|---|
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| | Sessional Exam II (Closed Book) | 20 |
| | Quizzes and Home Assignments / Class Assignments (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Closed Book) | 30 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Assignments (Formative) | Assignments are an integral part of the course. Home assignments / Class assignments will be provided from time to time. No late submissions will be entertained. It is expected that the students will work on the assignments independently. If any assignment is found copied from any source, marks will be deducted for the same. | |
| Make up Assignments | Students who miss a class will not be provided with any sort of makeup assignment or make up quiz. If you miss a lecture, you yourself have to study the topics that were covered during that particular lecture(s). You may contact the course coordinator for clarification of doubts, if any. | |

## E. SYLLABUS

Formulation of the objective function. Unconstrained single variable optimization: Newton, Quasi-Newton methods, polynomial approximation methods. Unconstrained multivariable optimization: Direct search method, conjugate search method, steepest descent method, conjugate gradient method, Newton's method. Linear Programming: Formulation of LP problem, graphical solution

of LP problem, simplex method, duality in Linear Programming, two-phase method. Nonlinear programming with constraints: Necessary and sufficiency conditions for a local extremum, Quadratic programming, successive quadratic programming, Generalized reduced gradient (GRG) method. Use of MS-Excel and MATLAB for solving optimization problems. Introduction to global optimization techniques. Applications of optimization in Chemical Engineering.

## F. TEXT BOOKS

T1. Edgar, T.F., Himmelblau, D. M., Ladson, L. S., Optimization of Chemical Process, 2nd ed., McGraw-Hill, 2001.

## G. REFERENCE BOOKS

R1. Rao, S. S., Optimization Techniques, Wiley Eastern, New Delhi, 1985.

R2. Godfrey, C.O. and Babu, B.V., New Optimization Techniques in Engineering, Springer-Verlag, Germany, 2004.

R3. Beveridge, G. S. and Schechter, R. S., Optimization Theory and Practice, McGraw- Hill, New York, 1975.

R4. Reklaitis, G.V., Ravindran, A. and Ragsdell, K. M., Engineering Optimization-Methods and Applications, Wiley India Pvt Ltd., 2006.

## H. LECTURE PLAN

| Lecture No. | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode Of Assessing CO |
|---|---|---|---|---|---|
| 1. | Introduction | Understand the nature and organization of optimization problems | Lecture | CE1804.1 | Assignment / quiz / Mid Term I |
| 2. | Problem formulation | Develop models for optimization | Lecture | CE1804.1 | Assignment / quiz / Mid Term I |
| 3. | Problem formulation | Formulate the objective function | Lecture | CE1804.1 | Assignment / quiz / Mid Term I |
| 4. | Optimization theory and methods | Learn the Basics concepts of Optimization | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 5. | Optimization theory and methods | Learn the Basics concepts of Optimization | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 6. | Optimization theory and methods | Learn the Basics concepts of Optimization | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 7. | Optimization theory and methods | To optimize unconstrained functions (one dimensional search) | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 8. | Optimization theory and methods | To optimize unconstrained functions (one dimensional search) | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 9. | Optimization theory and methods | To optimize unconstrained Multivariable functions | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 10. | Optimization theory and methods | To optimize unconstrained Multivariable functions | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 11. | Optimization theory and methods | To optimize unconstrained Multivariable functions | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |

| | | | | | |
|---|---|---|---|---|---|
| 12. | Optimization theory and methods | To optimize unconstrained Multivariable functions | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 13. | Optimization theory and methods | Understand the basics of Linear programming (LP) and its applications | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 14. | Optimization theory and methods | Understand the basics of Linear programming (LP) and its applications | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 15. | Optimization theory and methods | Understand the basics of Linear programming (LP) and its applications | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 16. | Optimization theory and methods | Understand the basics of Linear programming (LP) and its applications | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term I |
| 17. | Optimization theory and methods | Understand the basics of Nonlinear programming (NLP) with constraints | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term II |
| 18. | Optimization theory and methods | Understand the basics of Nonlinear programming (NLP) with constraints | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term II |
| 19. | Optimization theory and methods | Understand the basics of Nonlinear programming (NLP) with constraints | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term II |
| 20. | Optimization theory and methods | Understand the basics of Nonlinear programming (NLP) with constraints | Lecture | CE1804.1; CE1804.2 | Assignment / quiz / Mid Term II |
| 21. | Optimization theory and methods | Solution of global optimization problems with continuous and discrete variables | Lecture | CE1804.2 | Assignment / quiz / Mid Term II |
| 22. | Optimization theory and methods | Solution of global optimization problems with continuous and discrete variables | Lecture | CE1804.2 | Assignment / quiz / Mid Term II |
| 23. | Optimization theory and methods | Solution of global optimization problems with continuous and discrete variables | Lecture | CE1804.2 | Assignment / quiz / Mid Term II |
| 24. | Optimization theory and methods | Solution of global optimization problems with continuous and discrete variables | Lecture | CE1804.2 | Assignment / quiz / Mid Term II |
| 25. | Applications of optimization in Chemical Engineering | Optimization of Heat transfer and energy conservation problems | Lecture | CE1804.3 | Assignment / quiz / Mid Term II |
| 26. | Applications of optimization in Chemical Engineering | Optimization of Heat transfer and energy conservation problems | Lecture | CE1804.3 | Assignment / quiz / Mid Term II |
| 27. | Applications of optimization in Chemical Engineering | Optimization of Heat transfer and energy conservation problems | Lecture | CE1804.3 | Assignment / quiz / Mid Term II |
| 28. | Applications of optimization in Chemical Engineering | Optimization of Heat transfer and energy conservation problems | Lecture | CE1804.3 | Assignment / quiz / Mid Term II |
| 29. | Applications of optimization in Chemical Engineering | Optimization of Separation processes | Lecture | CE1804.3 | Assignment / quiz / Mid Term II |
| 30. | Applications of optimization in Chemical Engineering | Optimization of Separation processes | Lecture | CE1804.3 | Assignment / quiz / Mid Term II |
| 31. | Applications of optimization in Chemical Engineering | Optimization of Separation processes | Lecture | CE1804.3 | Assignment / quiz / End Term |
| 32. | Applications of optimization in Chemical Engineering | Optimization of Separation processes | Lecture | CE1804.3 | Assignment / quiz / End Term |

| | | | | | |
|---|---|---|---|---|---|
| 33. | Applications of optimization in Chemical Engineering | Optimization of Fluid flow systems | Lecture | CE1804.3 | Assignment / quiz / End Term |
| 34. | Applications of optimization in Chemical Engineering | Optimization of Fluid flow systems | Lecture | CE1804.3 | Assignment / quiz / End Term |
| 35. | Applications of optimization in Chemical Engineering | Optimization of Fluid flow systems | Lecture | CE1804.3 | Assignment / quiz / End Term |
| 36. | Applications of optimization in Chemical Engineering | Optimization of Fluid flow systems | Lecture | CE1804.3 | Assignment / quiz / End Term |
| 37. | Applications of optimization in Chemical Engineering | Optimization of Chemical reactor and its operation | Lecture | CE1804.3 | Assignment / quiz / End Term |
| 38. | Applications of optimization in Chemical Engineering | Optimization of Chemical reactor and its operation | Lecture | CE1804.3; CE1804.4 | Assignment / quiz / End Term |
| 39. | Applications of optimization in Chemical Engineering | Optimization of Chemical reactor and its operation | Lecture | CE1804.3; CE1804.4 | Assignment / quiz / End Term |
| 40. | Applications of optimization in Chemical Engineering | Optimization of Chemical reactor and its operation | Lecture | CE1804.3; CE1804.4 | Assignment / quiz / End Term |
| 41. | Applications of optimization in Chemical Engineering | Optimization in large-scale plant design and operations | Lecture | CE1804.3; CE1804.4 | Assignment / quiz / End Term |
| 42. | Applications of optimization in Chemical Engineering | Optimization in large-scale plant design and operations | Lecture | CE1804.3; CE1804.4 | Assignment / quiz / End Term |
| 43. | Applications of optimization in Chemical Engineering | Optimization in large-scale plant design and operations | Lecture | CE1804.3; CE1804.4 | Assignment / quiz / End Term |
| 44. | Applications of optimization in Chemical Engineering | Optimization in large-scale plant design and operations | Lecture | CE1804.3; CE1804.4 | Assignment / quiz / End Term |

## I. COURSE ARTICULATION MATRIX: (Mapping of COs with POs)

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| [CE1804.1] | Develop a mathematical statement for the objective function and the equality and inequality constraints | 3 | 3 | | | | | | | | | | 1 | 2 | | |
| [CE1804.2] | Implement the theory and applications of optimization techniques in a comprehensive manner for solving linear and non-linear, geometric, dynamic, integer and stochastic programming techniques | 3 | 2 | | | | 1 | | | | | 1 | 1 | | | |
| [CE1804.3] | Identify, formulate and solve a practical engineering problem of their interest by applying or modifying an optimization technique to enhance employability skills | 3 | 2 | 1 | | | | 1 | | | | 1 | 1 | 2 | | 2 |
| [CE1804.4] | Use of commercial software to optimize chemical processes thereby enhancing their skills. | | | 1 | | 3 | | | | 2 | 1 | 1 | 1 | 2 | 1 | 1 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**