## Summary Sheet

Department of Mechanical Engineering

2.6.1 Program outcomes, program specific outcomes and course outcomes for all programs offered by the institution are stated and displayed in website of the institution (to provide the weblink)

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For HOD ME

15/9/2021
Director SAMM

15-9-2021
Director Academics

Head of Department
Mechanical Engineering
Manipal University JAIPUR

# MANIPAL UNIVERSITY JAIPUR

Department of Mechanical Engineering
Course Hand-out

Value, Ethics and Governance | BB1101 | 2 Credits | 2002

Session: Jan–May 2021 | Faculty: Dr. Anjalee Narayan | Class: B.Tech.–Mechanical Engg. IV Semester

**A. 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.

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

**[1101.1]** Define the meaning and relevance of Value and Ethics and apply in personal & professional life.
**[1101.2]** Describe the importance of three Gunas for self-development, lifelong learning & growth.
**[1101.3]** Find issues and identify solutions related to Public & Private Governance systems.
**[1101.4]** Explain the relevance of Company's Act 2013 with reference to corporate world.
**[1101.5]** Explain the role and key objectives of organizational governance in relation to ethics and law.
**[1101.6]** Demonstrate the social & environmental responsibilities of corporate for sustainability, harmony and growth.

## C. 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 understandingof 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 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 theengineering 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

**[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].** Anability 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.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Mid SemExam 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. | |

**E. 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:** 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 responsibilities; Regulatory bodies; its role in ethical governance; Projects on PPP mode-relevance & prospects.

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

**F. 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*

**G. Lecture Plan:**

| Lecture 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 Mid Term I 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 Mid Term I End Term Exam |
| 3,4 | Professional Ethics & ethical dilemmas Case study-NeeravModi | To understand the role of professional ethics in the life & deal with dilemmas | Lecture | BB 1101.1 | In class Quiz, assignment Mid Term I 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, Mid Term I 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 assignment Mid Term I 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 Mid Term I 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 assignment Mid Term I End Term |
| 12,13 | Governance & its relevance Case studies- Bhopal Gas &Uphar Cinema | To acquaint with the concept of Governance | Lecture | BB 1101.3 | In Class Quiz Mid Term II End Term |
| 14 | Public Sector Governance: Need, relevance, stakeholders | Understand various aspects of public sector governance | Lecture | BB 1101.3 | Class Quiz, Mid Term II End Term |
| 15 | Public Finance, Audit & Control | Understand basics of Public Finance, Check & balance | Lecture Case study | BB 1101.3 | Class Quiz, assignment Mid Term II 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 Mid Term II 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 Mid Term II End Term |
| 20,21 | Role of Ethics in Governance Case studies- Satyam & Enron | Recognize the necessity of ethics & transparency in Governance | Movie : Gandhi | BB 1101.5 | Class Quiz, assignment Mid Term II 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, End Term |
| 24 | CSR Policy, Triple Bottom Line | Understand the concept of TBL in organizational frameworks | Lecture case study | BB 1101.6 | Class Quiz assignment End Term |
| 25,26 | Students' Presentation | Recall contents and their importance through case studies. | Flipped Class | ALL | Class Quiz 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 |
| BB1101.1 | Define the meaning and relevance of Value and Ethics and apply in personal & professional life. | | | 1 | | | 1 | 1 | 2 | 1 | 1 | | | | | 1 |
| BB1101.2 | Describe the importance of three Gunas for self-development, lifelong learning & growth. | | | 1 | | | 1 | 1 | 2 | 1 | 1 | | 2 | | | 1 |
| BB1101.3 | Find issues and identify solutions related to Public & Private Governance systems. | | | 2 | | | 1 | 1 | 2 | | | | | | | |
| BB1101.4 | Explain the relevance of Company's Act 2013 with reference to corporate world. | | | 2 | | | 1 | 1 | 2 | | | | | | | |
| BB1101.5 | Explain the role and key objectives of organizational governance in relation to ethics and law. | | | 2 | | | 1 | 1 | 2 | | 1 | | 1 | | | 1 |
| BB1101.6 | Demonstrate the social & environmental responsibilities of corporate for sustainability, harmony and growth. | | | 2 | | | 2 | 2 | 3 | 3 | 2 | 1 | 1 | | | 3 |

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

**A. Introduction:** This course is offered by Dept. of Economics to the Engineering departments, targeting students to give basic understanding in the concept of economics. It mainly deals with economic issues related to consumer behaviour, firms, industries and business organizations to make aware the students regarding economic environment. This course also discusses the preliminary concepts associated with macroeconomic variable like GDP inflation, balance of payments etc. It explores various possibilities emerging in an economy and the role of economic policy in this context.

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

[1323.1] Describe the basic principles of micro and macroeconomic analysis.
[1323.2] Interpret and illustrate decision making process in practical life.
[1323.3] Aware of the tools and techniques of economics for real world.
[1323.4] Recognize the problems and give solutions to it.
[1323.5] Recall the assumptions that underpin the Micro/Macro model.

**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

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| **Criteria** | **Description** | **Maximum Marks** |
| Internal Assessment (Summative) | Sessional Exam I | 15 |
| | Sessional Exam II | 15 |
| | Assignments , Activity, etc. | 30 |
| 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

Definition, nature and scope of economics; Introduction to micro and macroeconomics; law of demand and supply; elasticity of demand and supply; cardinal and ordinal approaches of utility; production, laws of production; cost and revenue analysis; various market situations; Break even analysis; Capital budgeting Macro Economics: National income and its concepts, value of money and its changes; foreign exchange rate; monetary and fiscal policies and other macro concepts (Balance of payments, Business cycles etc.)

## F. TEXT BOOKS

- P. Samuelson and Nordhaus, Economics, 19th Edition, Tata McGraw-Hill, 2008.
- Dornbusch, Fischer and Startz Macroeconomics, McGraw Hill, 2010
- H C Peterson, Managerial economics, Pearson, 9th Edition, 2012

## G. REFERENCE BOOKS

- P L Mehta, Managerial Economics, S Chand and company pvt. limited, New Delhi, 2012
- H L Ahuja, managerial economics, S Chand and company pvt. Limited,2010
- H.L. Ahuja, Advanced Economic Theory: Microeconomic Analysis, S. Chand and Co. Limited, New Delhi, 2007
- Lipsey & Chrystal, Economics, Oxford University Press, 2011.
- Richard T. Froyen, Macroeconomics, Pearson Education Asia, 2005

**H. Lecture Plan:**

| Lec No | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Overview of the course structure | To acquaint and clear the overview of the course | Lecture | NA | NA |
| 2 | Objective of the course | Discussion of the objective of the course for the engineers | Lecture | NA | NA |
| 3,4 | Definition, nature and scope of economics, introduction to micro and macroeconomics | Describe the concept given by different economists, its scope, differences between micro and macro economics | Lecture | 1323.1 | Class Test<br>Mid Term I |
| 5,6,7, | Cardinal approaches of utility | Describe the concept of cardinal approach of utility, Law of DMU and equi marginal utility | Lecture | 1323.1 | Class Test<br>Mid Term I |
| 8,9,10,11 | Law of demand and supply, elasticity of demand and supply | Describe the concept of demand, supply, elasticity of demand and supply with examples, conceptual questions | Lecture | 1323.1 | Class Test<br>Mid Term I |
| 12 | Revision of previous lectures | Recall all the concepts discussed in previous classes | Lecture | 1323.5 | Class Test<br>Mid Term I<br>End Term |
| 13 | Discussion of the topics related to assignment | Discussion about the assignment topics | Lecture, Activity | | Home Assignment<br>Mid Term 1<br>End term |
| 14,15,16 | Ordinal approaches of utility | Recall of the differences between the concept of the cardinal approach and ordinal approach of utility , IC analysis, Consumers equilibrium, IE,SE,PE | Lecture | 1323.5 | Class Test<br>Mid Term I<br>End Term |
| 17,18,19 | Production, laws of production | Discussion of the concept of production, recognize production function, producers equilibrium, RTS | Lecture | 1323.4 | Class Test<br>Mid Term II<br>End Term |
| 20,21 | Cost and revenue analysis | Discussion of the concept of cost and cost function, recognize SR and LR cost curves, revenues | Lecture | 1323.4 | Class Test<br>Mid Term II<br>End Term |
| 22,23 | Various market situations; Break even analysis | Aware of market morphology with examples, Interpret and illustrate BEA | Lecture | 1323.3 | Class Test<br>Mid Term II<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 24 | Revision of previous lectures | Recall all the concepts discussed in previous classes | Lecture | 1323.5 | Class Test<br>Mid Term II<br>End Term |
| 25 | Discussion of the topics related to assignment | Recall the discussion about the assignment topics | Lecture, Activity | 1323.5 | Home Assignment<br>Mid Term II<br>End term |
| 26 | Capital budgeting | Interpret and illustrate the concept of CB and various tools | Lecture | 1323.2 | Home Assignment<br>Class Test<br>End Term |
| 27,28 | Macro Economics: National income and its concepts | Interpret and illustrate the concept of NI,GDP,GNI,PI etc., circular flow | Lecture | 1323.2 | Home Assignment<br>Class Test<br>End Term |
| 31,32,33 | Monetary and fiscal policies | Concept of monetary and fiscal policies, Aware of its instruments, importance and limitations | Lecture | 1323.3 | Home Assignment<br>Class Test<br>End Term |
| 34,35 | Inflation | Concept of inflation, Aware of demand pull and cost push inflation | Lecture | 1323.3 | Home Assignment<br>Class Test<br>End Term |
| 36,37 | Various macro concepts: Balance of payments, Business cycles | Aware of the concept of BOP, Business cycles | Lecture | 1323.3 | Home Assignment<br>Class Test<br>End Term |
| 38 | Discussion of the topics related to end sessional examination | Recall the discussion about the assignment topics | Lecture | 1323.5 | End Term |
| 39 | Conclusion and Course Summarization | Recall all the concepts discussed in previous classes | Lecture | 1323.5 | 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 |
| EO 1323. 1 | Describe the basic principles of micro and macroeconomic analysis | | | | | | | | | 1 | | 2 | 2 | | | |
| EO 1323. 2 | Interpret and illustrate decision making process in practical life | | | | | | 1 | | | 2 | | | 2 | | | |
| EO 1323. 3 | Aware of the tools and techniques of economics for real world | | | | | | | | | 2 | | 2 | 2 | | | |
| EO 1323. 4 | Recognize the problems and give solutions to it | | | | | | | | | 2 | | 2 | 2 | | | |
| EO 1323. 5 | Recall the assumptions that underpin the Micro/Macro model. | | | | | | | | | 2 | | | 2 | | | |

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

**A. Introduction:** This course is offered by Dept. of Mathematics as core subject, targeting students who wish to pursue research& development in industries or higher studies in field of Engineering Mathematics. Offers in depth knowledge Laplace and Fourier transform, Numerical analysis, Fourier series and vector calculus. Students are expected to have background knowledge on integration and differentiation for a better learning.

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

[**MA1313.**1] Describe the concept of Laplace Transform & their properties to apply in real world problems which enhance their analytical skills in solving the related problems in engineering.

**[MA1313.2**] Describe the problems of engineering by using Numerical analysis.

[**MA1313.3**] Describe the concepts and properties of gradient, divergence and curl to formulate engineering problems and convert line integrals into area integrals and surface integrals into volume integrals by using suitable theorems.

**[MA1313.4**] Describe the concept and properties of periodic functions by Fourier series and apply them to evaluate the related problems.

[**MA1313.5**] Relate the concepts of the Fourier transforms and apply them to solve problems arising in Engineering, which increase the employability in the related field.

**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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environmental contexts, and demonstrate the knowledge of, and need for sustainable development

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**[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].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| 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. | |
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**E. SYLLABUS**

**Vector Calculus**: gradient, divergence and curl, vector integrals, related theorems

**Laplace Transforms**: Transforms of elementary functions, inverse transforms, convolution theorem. Application of Laplace in solutions of differential equations with constant coefficients.

**Fourier series:** Fourier series, Dirichlet's, even and odd functions, half range series, change of interval, harmonic analysis.

**Fourier Transforms:** Fourier integrals, Complex Fourier transform, Fourier sine and cosine transforms, solution of heat and wave equations.

**Finite Differences and Interpolation:** Finite difference operators, Newton's forward and forward interpolation formula, Lagrange's and Stirling interpolation formula. Numerical differentiation and integration.

**F. Text Books:**

1. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, Delhi, 2006.
2. Srimanta Pal, Subhdh C. Bhunia, "Engineering Mathematics", Oxford University Press, 2015.
3. H. K. Das, "Advanced Engineering Mathematics" S. Chand, 2015.

**G. References:**

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India Eastern, 2006.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Education Private Limited, New Delhi 2007.

**H. Lecture Plan:**

| S.No. | TOPICS | Session Outcome | Mode of Delivery | Corresponding CO | Mode of assessing the outcome |
|---|---|---|---|---|---|
| **Laplace Transform:** | | | | | |
| 1 | Introduction and Course Hand-out briefing : Definition of LT. LT of elementary functions. | Understanding the basics of Integral Transform & Laplace Transform | Lecture | MA1313.1 | MTE-I Assignment & Quiz Test ETE |
| 2-4 | Properties of LT: linearity, First shifting, second shifting, change of scale, Multiplication by t, division by t, Derivative property, Integral Property ,Initial Value Problem, Final Value Problem (Without Proof) | Describe various properties of Laplace Transform | Lecture | MA1313.1 | MTE-I Assignment & Quiz Test ETE |
| 5-6 | Inverse transforms, convolution theorem. | Discuss Inverse laplace Transform with theorems | Lecture | MA1313.1 | MTE-I Assignment & Quiz Test ETE |
| 7 | Application of Laplace in solutions of differential equations with constant coefficients. | Application of Laplace Transform in solving differential equations | Lecture | MA1313.1 | MTE-I Assignment & Quiz Test ETE |
| **Finite Differences and Interpolation** | | | | | |
| 8 | Introduction of Numerical Analysis: Finite difference operators | Describe Finite difference operators | Lecture | MA1313.2 | MTE-I Assignment & Quiz Test ETE |
| 9-10 | Newton's- Gregory forward and backword interpolation formula, | Describe forward and Backward interpolation formula | Lecture | MA1313.2 | MTE-I Assignment & Quiz Test ETE |

| | | | | | |
|---|---|---|---|---|---|
| 11-12 | Stirling interpolation & Lagrange's | Describe central difference formula and formula for unequal intervals | Lecture | MA1313.2 | MTE-II Assignment & Quiz Test ETE |
| 13-14 | Numerical Differentiation (For Forward, Backward, Stirling) | Discuss Numerical differentiation | Lecture | MA1313.2 | MTE-II Assignment & Quiz Test ETE |
| 15-17 | Numerical Integration( Quadrature formula, Trapezoidal rule, Simpson 1/3rule, Simpson's 3/8 rule, Weddle rule | Describe numerical Integration | Lecture | MA1313.2 | MTE-II Assignment & Quiz Test ETE |
| **Vector Calculus:** | | | | | |
| 18-20 | gradient, divergence and curl | Describe Basics of Vector calculus | Lecture | MA1313.3 | MTE-II Assignment & Quiz Test ETE |
| 21-23 | vector integrals | Describe Vector integrals | Lecture | MA1313.3 | MTE-II Assignment & Quiz Test ETE |
| 24-27 | Greens, Stokes and Gauss Divergence theorem | Discuss various theorems of vector calculus and their properties | Lecture | MA1313.3 | MTE-II Assignment & Quiz Test ETE |
| **Fourier series:** | | | | | |
| 28-29 | Fourier series, Dirichlet Condition | Explain properties and basics of fourier Series | Lecture | MA1313.4 | MTE-II Assignment & Quiz Test ETE |
| 30 | even and odd functions half range series | Describe series of even and odd functions | Lecture | MA1313.4 | MTE-II Assignment & Quiz Test ETE |
| 31 | change of interval | Describe fourier series for change of interval | Lecture | MA1313.4 | ETE Assignment & Quiz Test |
| 32-33 | Harmonic analysis | Describe Harmonic analysis | Lecture | MA1313.4 | ETE Assignment & Quiz Test |
| **Fourier Transforms:** | | | | | |
| 34 | Fourier integrals | Describe basics of Fourier Transform and fourier integrals | Lecture | MA1313.5 | ETE Assignment & Quiz Test |
| 35-36 | Complex Fourier transform, Fourier sine and cosine transforms, | Describe Fourier sine & cosine transform | Lecture | MA1313.5 | ETE Assignment & Quiz Test |
| 37-38 | Properties of Fourier Transform | Describe Properties of Fourier Transform | Lecture | MA1313.5 | ETE Assignment & Quiz Test |
| 39-40 | solution of heat and wave equations | Describe Application of Fourier Transform | Lecture | MA1313.5 | ETE Assignment & Quiz Test |
| END SEMESTER EXAMINATION | | | | | |

## 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 |
| MA 1313.1 | Describe the concept of Laplace Transform & their properties to apply in real world problems which enhance their analytical skills in solving the related problems in engineering. | 2 | 2 | 1 | 1 | | | | | | | | 1 | 3 | | 1 |
| MA 1313.2 | Describe the problems of engineering by using Numerical analysis. | 3 | 2 | | | | | | | | 2 | | 1 | | 2 | 1 |
| MA 1313.3 | Describe the concepts and properties of gradient, divergence and curl to formulate engineering problems and convert line integrals into area integrals and surface integrals into volume integrals by using suitable theorems. | 2 | 2 | 1 | | 2 | | | | | | | 1 | | | 1 |
| MA 1313.4 | Describe the concept and properties of periodic functions by Fourier series and apply them to evaluate the related problems. | 2 | 2 | | | | | | | | 1 | | 1 | | | 1 |
| MA 1313.5 | Describe the concepts of the Fourier transforms and apply them to solve problems arising in Engineering, which increase the employability in the related field. | 2 | 2 | 1 | | 1 | | | | | | | 1 | | | 1 |

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

# MANIPAL UNIVERSITY JAIPUR

School of Basic Sciences

Department of Mathematics and Statistics

Course Hand-out

Engineering Mathematics IV| MA1410 | 3 Credits | 3 0 0 3

Session: Jan 21 – May 21 | Faculty: Dr. Bhoopendra Pachauri| Class: Compulsory

**A.** **Introduction:** In the first part the student will be acquainted with some numerical methods like approximation of functions, solution of nonlinear equations, approximate determination of a derivative and an integral, and solution of differential equations which are suitable for modelling various problems of practice. The other part of the subject yields fundamental knowledge from the probability theory (random event, probability, characteristics of random variables, probability distributions) which is necessary for simulation of random processes.

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

**[2403(N).1].**Student will understand and use the measure of central tendency in daily life problems

**[2403(N).2].**Student will be able to compute the probabilities using basic rules of probability

**[140(N).3].**Student will apply concepts of probability in decision making and industry applications

**[140(N).4].**The numerical methods will equip students to solve many engineering problems related to electrical theory.

**[140(N).5].**Students will be able to numerically solve problems of algebraic and transcendental equations, interpolation, initial value problem in engineering.

## 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]. Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

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**C. 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) | 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

**Statistics and Probability:** Measures of central tendency and dispersion, Random variables, Expectation, Moments and Moment generating functions. Probability distributions: Binomial, Poisson, Normal, Gamma and exponential distributions.

**Numerical methods:** Interpolation and extrapolation, Numerical differentiation & integration. Solution of differential equation: Picard's, Taylor series, Euler's & Euler's Modified methods, RungeKutta $4^{th}$ order methods. Solution of system of linear algebraic equations: Gauss Jacobi, Gauss Seidel, relaxation methods. Largest eigen value by the power method.

## E. TEXT BOOKS

T1V. Sundarapandian, "Probabilty, Statistics and Queuing Theory", PHI, 2013.

T2B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, Delhi, 2006

## F. REFERENCE BOOKS

R1 P. Kousalya, "Probability, Statistics and Random Processes", Pearson, 2013.

R2 Richard A. Johnson and C.B. Gupta, "Probability and Statistics for Engineers", Pearson Education, 2009.

R3 S. S. Sastry, "Introductory Methods of Numerical Analysis", PHI, 2005

| Lec No | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | **Probability**: Basic Concepts | To acquaint students basic idea of probility | Lecture | NA | NA |
| 2 | Laws of Probability: Addition and Multiplication Laws | Recall and learn probability law | Lecture | 2403(N).2 | In Class Quiz |

| | | | | | |
|---|---|---|---|---|---|
| 3,4 | Conditional probability | Understand the concept of conditional probility | Lecture | 2403(N).2 | Home assignment |
| 5,6 | Bays Theorem: Concepts and problems | Explain and solve problems of probability | Lecture | 2403(N).2 | Home Assignment<br>End Term |
| 7.8 | Random Variable: Concepts and problems | Understand the concept of random variable | Lecture | 2403(N).2 | In Class Quiz<br>End Term |
| 9 | Expectations | Use the concept of weighted average to problems | Lecture | 2403(N).2 | Class Quiz<br>Mid Term I<br>End Term |
| 0 | Moments | Connect average and expectations | Lecture | 2403(N).2 | Class Quiz |
| | | | | | Mid Term I<br>End term |
| 11 | Probability Distributions | Understand the concept of distributions and apply to problems | Lecture | 2403(N).3 | Home Assignment<br>Class Quiz<br>Mid Term I |
| 12 | Binomial Distribution | Understand the concept of distributions and apply to problems | Lecture | 2403(N).3 | Class Quiz<br>Mid Term I<br>End Term |
| 13 | Poisson Distribution | Apply to real problems | Lecture | 2403(N).3 | Class Quiz<br>Mid Term I<br>End Term |
| 14 | Gamma Distribution, Exponential Distribution | Use in reliability theory | Lecture | 2403(N).3 | Class Quiz<br>End Term |
| 15,16 | Normal distribution | Understand the concept and will apply to problems | Lecture | 2403(N).3 | Class Quiz<br>Mid Term II<br>End Term |
| 17 | Measures of central tendency and dispersion: Mean Mode median | Able to solve real world problems | Lecture | 2403(N).1 | Class Quiz<br>Mid Term II<br>End Term |
| 18 | Measures of central tendency and dispersion: Dispersion, quartile | Able to solve real world problems | Lecture | 2403(N).1 | Class Quiz<br>Mid Term II<br>End Term |
| 19 | Interpolation and Extrapolation: Newton forward and backward formul | Understand the concept and apply to problems | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>Mid Term II<br>End Term |
| 20 | Stirling formula | Understand the concept and apply to problems with rational | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 21 | Bessels formula | Understand the concept and apply to problems and analysis vis a vis other mothds | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>End Term |
| 22 | Langrange's interpolation formula | Understand the difference with other methods | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>End Term |
| 23 | Numerical Differentiation: Newton's forward difference formula | Understand the concept and apply to problems | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>End Term |
| 24 | Newton's forward difference formula | | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>End Term |
| 25 | Newton's backward differences formula | Understand the concept and apply to problems | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>End term |
| 26 | Strirling's central difference formula | Understand difference with other methods | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz |
| 27 | Numerical Integration: The Trapezoidal rule | Understand the useful of numerical integration | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>Mid Term II |
| | | | | | End Term |
| 28,29 | Simpson's one third rule & Three Eighth Rule | Understand the useful of numerical integration | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>Mid Term II<br>End Term |
| 30,31 | Solution of differential equation: Picard's, Taylor series | Construct and apply and compare the solutions | Lecture | 2403(N).5<br>2403(N).4 | Class Quiz<br>Mid Term II<br>End Term |
| 32,33 | Euler's & Euler's Modified Methods | Construct and apply and compare the solutions | Lecture | 2403(N).5<br>2403(N).4 | Mid term II<br>End Term |
| 34,35 | Rungekutta 4$^{th}$ order | Construct and apply and compare the solutions, importance of method | Lecture | 2403(N).5<br>2403(N).4 | End Term |
| 36 | Solution of System of Linear Equations: Gauss Jacobi Method | Apply numerical approach to obtain solution | Lecture | 2403(N).5<br>2403(N).4 | End Term |
| 37,38 | Gauss-Seidel Iteration Method | Apply numerical approach to obtain solution | Lecture | 2403(N).5<br>2403(N).4 | End Term |
| 39,40 | Relaxation Method | Apply numerical approach to obtain solution | Lecture | 2403(N).5<br>2403(N).4 | End Term |
| 40 | Conclusion and Course Summarization | Value and anlysis | Lecture | | Class Quiz<br>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 |
| MA 1408.1 | Student will understand and use the measure of central tendency in daily life problems | 2 | | 3 | 3 | 2 | 2 | | | 3 | | 2 | 2 | 2 | 3 | |
| MA 1408.2 | Student will be able to compute the probabilities using basic rules of probability | 2 | 3 | 2 | | 2 | | | | | | 3 | 2 | 2 | 2 | |
| MA 1408.3 | Student will apply concepts of probability in decision making and industry applications | 3 | 3 | 3 | 1 | 2 | 2 | | | | | 2 | 2 | 2 | 2 | 3 |
| MA 1408.4 | The numerical methods will equip students to solve many engineering problems related to communication theory. | 2 | 2 | 2 | | 2 | | | | | | | 2 | 2 | | 2 |
| MA 1408.5 | Students will be able to numerically solve problems of algebraic and transcendental equations, interpolation, initial value problem in engineering | 2 | 3 | 2 | 3 | 2 | 1 | | | | | | 1 | 2 | | 2 |

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

**A. INTRODUCTION:** This course is offered by Department of Mechanical Engineering as programme elective. This course aims to provide a physical basis that links the structure of materials with their properties. Emphasis will be on the "processing, structure, properties, and performance" relationships that lead to the development of materials for society's needs. This course will expose the students to different classes of materials, their properties, structures and imperfections present in them. It will help understand the subject with ease by presenting the content in a simplified and logical sequence. It will aid the teaching learning process through relevant illustrations, animations, web content and practical examples. The course will highlight important concepts for each topic covered in the subject. Finally this course will provide opportunity of self-evaluation on the understanding of the subject matter.

**B. COURSE OUTCOMES:** At the end of the course, students will be

**[2301.1]** aware of different class of materials including modern materials such as nano-, bio-, composite, and smart materials and their application areas.
**[2301.2]** able to understand the structure of materials, lattice arrangements and crystallography, imperfections in crystalline solids, and their effects on different properties of materials**.**
**[2301.3]** understand phases in materials, the concept of phase transformations and its influence on properties of engineering materials.
**[2301.4]** understand loading environments, mechanical testing, failure mechanisms, and interpret the test results.
**[2301.5]** offer different approaches to modify structure/microstructure of engineering materials to get desired properties.
**[2301.6]** select appropriate material for designing and manufacturing of products.

**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 understanding 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.

**Programme Specific Outcomes:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**ASSESSMENT PLAN**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I | 15 |
| | Sessional Exam II | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| 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. | |

## D. SYLLABUS

Introduction to Materials Science and Engineering: Materials classification. Crystallography SC, FCC, BCC, HCP structures, APF; Miller indices: Crystal structure determination-X-ray diffraction techniques, Microscopic examination; Imperfections in Crystals: Point defects, line defects, surface defects. Plastic Deformation of Metals and Alloys, Mechanisms of plastic deformation, role of Dislocation; slip and twinning, grain growth, Solidification of Metals and Alloys: Solid solution, Hume Rothery's rules, Phase diagrams- Phase and Lever Rules relationship of micro Structure and properties, Iron- Carbon equilibrium diagram, Development of microstructure in Iron Carbon alloys, Phase transformation Mechanical Properties of Metals; Fatigue and Failure of materials. Polymers and applications: Types of polymers, structure and applications; Hydrocarbon and polymer molecules, Molecular weight, shape, structure and configurations, Thermosetting and thermoplastic polymers; Characteristics and

Applications of Polymers; Mechanical behavior of polymers, mechanisms of deformation; Crystallization, Melting, and Glass transition phenomena, Application and Properties of Ceramics: Types and applications of ceramics; Ceramic manufacturing; Mechanical and other properties. Fabrication of Plastics, Fibres and Films; Composites Materials: FRP, MMC, PMC and other types and applications; Fibre, Particle reinforced composites, Structural composites; Biocomposites, Nanocomposites, Composite micromechanics. Advanced Materials: Smart materials, Biomaterials, Nanomaterials.

**Prescribed Text Book**

T1. Callister William D & R. Balasubramaniam, Materials Science and Engineering, Wiley Student Edition, 7th Edition, 2007.

**Reference Books**

R1. William F Smith, Javad Hashmi and Ravi Prakash, Materials Science and Engineering, Fourth Edition, Tata Mcgraw Hill Education Private Limited, New Delhi.

R2. George E. Dieter, Mechanical Metallurgy, SI Metric Edition McGraw Hill Book Company, London.

R3. R. A. Higgins, Applied Physical Metallurgy, Sixth edition, Viva Low priced students edition, New Delhi.

R4. Thomas. H. Courtney, "Mechanical Behaviour of Materials", McGraw Hill Publication company, Materials Science series, II Edition, 2000.

## E. LECTURE PLAN

| Lecture | Topic | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| **L1** | Introduction, Scope and Objectives of the Course | To acquaint and clear teachers expectations and understand student expectations | Lecture/PPT | **[2301.1]** | NA |
| **L2** | Classification of Engineering Materials and Applications | Students will understand the importance of 'Engineering Materials' | Coursera/Lecture/PPT | **[2301.1]** | Mid-Term 1 /End-Term |
| **L3** | Mechanical Properties of Materials | Describe mechanical properties of metals | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 1 |
| **L4** | Concepts Check, Numerical Problem Solving | Problem Solving | Lecture/PPT | | |
| **L5** | Atomic Structure and Electron Configuration | Students will be able to understand fundamental structure of materials | Coursera/Lecture/PPT | **[2301.2]** | Mid-Term 1 |
| **L6** | Concepts Check, Numerical Problem Solving | Problem Solving | Lecture/PPT | | |
| **L7** | The Structure of Crystalline Solids | Discuss different types of crystal structures | Coursera/Lecture/PPT | **[2301.2]** | Mid-Term 1 Quiz |
| **L8** | Crystallography, SC, FCC, BCC, HCP Structure | Understand in detail about various crystal structures | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 1 /End-Term |
| **L9** | Concepts Check, Numerical Problem Solving | Problem Solving | Lecture/PPT | | |
| **L10** | Miller Indices, Application for Planes and Directions | Students will understand assignment of crystal structures and notations | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 1 /End-Term |
| **L11** | Atomic Packing Factor (APF), Concepts Check, Numerical Problem Solving | Problem Solving | Lecture/PPT | **[2301.3]** | Mid-Term 1 /End-Term |

| | | | | | |
|---|---|---|---|---|---|
| **L12** | Imperfections in Solids: point/line/solid defects | Students will understand about various defects and their effects. | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 1 /End-Term |
| **L13** | Dislocations, Types and Influence on Mechanical Properties: slip/twinning/plastic deformation | Students will understand effect of dislocations and their effects. | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 1 /End-Term |
| **L14** | Concepts Check of slip/twinning/plastic deformation, Numerical Problem Solving | Problem Solving. | Lecture/PPT | **[2301.3]** | Mid-Term 1 |
| **L15** | Fatigue and Failure of materials | Fatigue and failure properties of metals. | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 1 Quiz |
| **L16** | Characterization Techniques of Materials X-ray diffraction/ Electron Microscopy | Learn about various characterization techniques. | Lecture/PPT | **[2301.3]** | Mid-Term 1 /End-Term |
| **L17** | Concepts Check, Numerical Problem Solving | Problem Solving | Lecture/PPT | **[2301.3]** | |
| **L18** | Solidification of Metals and Alloys | Describe various solidification processes. | Lecture/PPT | **[2301.3]** | Lecture/PPT |
| **L19** | Work hardening/recovery recrystallization/ grain growth | Describe concept of grain growth and hardening/ recrystallization process of materials | Lecture/PPT | **[2301.5]** | Mid-Term 1 /End-Term |
| **L19** | Phase Diagrams: Introduction and Basic Concepts | Understand importance of phase diagrams | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 2//End-Term |
| **L20** | Binary Phase Diagrams | Learn about binary phase diagrams | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 2//End-Term |
| **L21** | Iron-Carbon System | Learn about various iron-carbon system. | Lecture/PPT | **[2301.3]** | Mid-Term 2//End-Term |
| **L22** | TTT diagram | | | | Mid-Term 2//End-Term |
| **L23** | Concepts Check, Numerical Problem Solving | Problem Solving. | Lecture/PPT | **[2301.3]** | |

| | | | | | |
|---|---|---|---|---|---|
| **L24** | Fabrication of Metals | Understand various metal fabrication techniques. | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 2 |
| **L25** | Ceramics and Glasses | Understand various types of ceramics glasses | Lecture/PPT | **[2301.3]** | Mid-Term 2//End-Term |
| **L26** | Structure and Properties of Ceramics | Learn about various structures and properties of ceramics. | Lecture/PPT | **[2301.3]** | Assignment & Discussion |
| **L27** | Ceramic Manufacturing | Learn about various manufacturing processes | Lecture/PPT | **[2301.3]** | Mid-Term 2//End-Term |
| **L28** | Applications and Processing of Ceramics | Learn applications and processing | Coursera/Lecture/PPT | **[2301.4]** **[2301.6]** | Mid-Term 2//End-Term |
| **L29** | Polymers and Elastomers | Describe various mechanical properties of nanoparticles | Coursera/Lecture/PPT | **[2301.3]** | Mid-Term 2 |
| **L30** | Structures of Polymers | Understand importance of optical properties and possible areas of applications. | Coursera/Lecture/PPT | **[2301.5]** | Mid-Term 2//End-Term |
| **L31** | Processing, Characteristics, and Applications of Polymers | Describe various electrical properties | Lecture/PPT | **[2301.5]** **[2301.6]** | Assignment & Discussion |
| **L32** | Mechanical and Thermal Properties of Polymers | Identify carbon nanoparticles and their applications | Lecture/PPT | **[2301.3]** | Mid-Term 2 |
| **L33** | Fabrication of Plastics, Fibres and Films | Identify non-carbon nanoparticles and their applications | Lecture/PPT | **[2301.3]** | Mid-Term 2 |
| **L34** | Composites Materials: Classification | Identify various safety concerns and toxicological effects | Coursera/Lecture/PPT | **[2301.4]** | Mid-Term 2//End-Term |
| **L35** | Structure, Properties and Applications of Composites | Identify various environmental concerns | Coursera/Lecture/PPT | **[2301.5]** **[2301.6]** | Mid-Term 2//End-Term |

| | | | | | |
|---|---|---|---|---|---|
| **L36** | Fabrication of Composites Characterization of Composites | Identify and discuss application areas of nanotechnology | Coursera/Lecture/PPT | **[2301.5]** | Mid-Term 2//End-Term |
| **L37** | Biocomposites and Bioplastics | Identify and discuss application areas of nanotechnology | Lecture/PPT | **[2301.1]** | Mid-Term 2 |
| **L38** | Smart Materials: Types and Applications | Identify and discuss application areas of smart materials | Courseara/Lecture/PPT | **[2301.1]** | Mid-Term 2//End-Term |
| **L39** | Biomaterials: Structure, Properties and Applications | Identify and discuss application areas of Biomaterials | Lecture/PPT | **[2301.1]** | Mid-Term 2 |
| **L40** | Nanomaterials: Structure, Properties and Applications | Identify and discuss application areas of nanomaterials | Coursera/Lecture/PPT | **[2301.1]** | Mid-Term 2//End-Term |
| **L41** | Concepts Check, Numerical Problem Solving | Problem Solving | Lecture/PPT | | |

**F. 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 |
| **[2301.1]** | aware of different class of materials including modern materials such as nano-, bio-, composite, and smart materials and their application areas. | 3 | 1 | | | | | | | | | | 1 | 1 | | |
| **[2301.2]** | understand the structure of materials, lattice arrangements and crystallography, imperfections in crystalline solids, and their effects on different properties of materials**.** | 3 | 2 | 2 | | 2 | | | | | | | 1 | 2 | | |
| **[2301.3]** | understand phases in materials, the concept of phase transformations and its influence on properties of engineering materials. | 2 | 2 | | | 2 | | | | | | | | 1 | | |
| **[2301.4]** | understand loading environments, mechanical testing, failure mechanisms, and interpret the test results. | 3 | 2 | 2 | | 2 | | 2 | | | | | | 1 | | |
| **[2301.5]** | offer different approaches to modify structure/microstructure of engineering materials to get desired properties. | 2 | 1 | 1 | | 1 | | | | | | | 1 | 1 | | |
| **[2301.6]** | select appropriate material for designing and manufacturing of products. | 3 | 2 | 3 | | 3 | | | | | | | | 1 | | |

**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

Kinematics of Machines| ME 2302 | 4 Credits | 4 0 0 4

Session: July 20 – Dec 20 | Faculty: Ashish Sharma/Ashish Srivastava/Ramanpreet

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering which focuses on mainly kinematics and mechanism. It deals with degree of freedom of mechanism and machines, in addition to this it also covers velocity and acceleration analysis. This course gives an overview of fundamental working of brakes, clutches and various gear box. This course is pre-requisite for dynamics of machines which deals with force analysis.

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

**ME2302.1** Understand the concepts of linkage and their relative motion.
**ME2302.2** Co-relate all the mechanism with real life machines.
**ME2302.3** Analyse the velocity and acceleration of different mechanism.
**ME2302.4** Create specific cam profile for specific follower movement.
**ME2302.5** Understand gear terminologies and various parameters related to gear motion such as path analysis and employability skills.
**ME2302.6** Evaluate the forces and motion of transmission devices like differential gear box and clutches.

## 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.

**Programme Specific Outcomes**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 15 |
| | Sessional Exam II (Open Book) | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open 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

- Mechanism and Machine: Constrained motion, rigid and resistant bodies, link, kinematic pair and degrees of freedom. kinematic chain: Linkage mechanism and structure, mobility and range of movement - Kutzbach and Grubler's criterion, number synthesis, Grashof's criterion, Four bar chain and slider crank chain and its inversions.
- Introduction to synthesis of mechanism: Transmission angle, definition and determination of maximum and minimum

transmission angle, two and three position synthesis of four bar mechanism and slider crank mechanism using graphical method.

- Displacement, velocity and acceleration analysis of plane mechanisms: Graphical and analytical methods, plane motion of a rigid body, Instantaneous Centre (IC) of velocity, velocity analysis using IC, velocity and acceleration diagrams, Corioli's component of acceleration.
- Cam: Types, followers, definitions, displacement, derivatives, design of cam profiles, lay out and different types of contours of cams.
- Gear: Law of gearing, Spur Gears: definitions, cycloidal and involute teeth, rack and pinion, path of contact, arc of contact, minimum number of teeth , methods of avoiding interference, terminology of helical and bevel gears.
- Gear Trains: Simple, compound, reverted, epicyclic gear trains, problems to be solved by tabular method, torque calculations, automobile differential gear mechanism.
- Clutch and Brake: Uniform pressure and wear theory, different types of clutches, different types of brakes, band and block brake, types of dynamometer.

## F. TEXT BOOKS


1. S. S. Rattan, "Theory of machines" Tata McGraw Hill, 4th Edition, 2014.
2. Amitabha Ghosh & Asok Kumar Mallik, "Theory of Mechanisms and Machines" East West Press, 3rd Edition, 2006


## G. REFERENCE BOOKS


- Hamilton H. Mabie and Charles, "Mechanisms and dynamics of machinery" John Wiley and sons, 4th Edition1987.
- J.E.Shigley and Jr.Uicker, "Theory of Machines and Mechanisms" Oxford University press, 4th Edition, 2011.
- R L Norton, "Kinematics and Dynamics of Machinery" Tata McGraw-Hill Education, 1st Edition in SI unit, 2009.

**H. Lecture Plan:**

| Lec No | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | Introduction to machines and mechanism | To acquaint and clear teachers expectations and understand student expectations | Lecture | NA | NA |
| 2 | Types of kinematics Pair, Types of links, Rigid bodies and Links | Knowledge of basics of kinematics linkage | Flipped Classroom | 2302.1 | In Class Quiz ( Not Accounted) |
| 3,4 | Degree of freedom, Grublers' criterion | Able to understand mechanism input and specific output | Lecture | 2302.1 | In Class Quiz<br>End Term<br>Mid Term I |
| 5,6 | Four bar linkage, Slider crank mechanism | Practice of concept based numerical problems - I | Tutorial cum Lecture | 2302.1 | Class Quiz<br>Mid Term I<br>End Term |
| 7,8 | Problems on DoF | Practice of concept based numerical problems - II | Tutorial cum Lecture | 2302.1 | Class Quiz<br>Mid Term I<br>End Term |
| 9 | Grashofs' law<br>Transmission angle | Able to analyse various four bar inversions | Lecture | 2302.1 | Class Quiz<br>Mid Term I<br>End Term |
| 10 | Inversions of mechanism | Able to analyse various inversions | Tutorial cum Lecture | 2302.1 | Class Quiz<br>Mid Term I<br>End term<br>Home Assignment |
| 11,12 | Synthesis of mechanism, Two and three position synthesis<br>Problems on inversion | Analyse the motion of mechanism | Tutorial cum Lecture | 2302.2 | Class Quiz<br>Mid Term I<br>End Term |
| 13,14 | Velocity Analysis Introduction | Have basics of velocity analysis | Lecture | 2302.3 | Class Quiz<br>Mid Term I<br>End Term |
| 15,16 | Instantaneous centre, Kennedy theorem<br>Angular velocity theorem | Able to understand the velocity of different links and their motion | Lecture | 2302.3 | Class Quiz<br>Mid Term I<br>End Term |
| 17,18 | Problems for velocity analysis | Analyse the total torque and its effect on crank shaft | Tutorial cum Lecture | 2302.3 | Class Quiz<br>Mid Term I<br>End Term |
| 19,20 | Vector graphical method, Problems on velocity of mechanism | Practice of concept based numerical problems - III | Lecture | 2302.3 | Class Quiz<br>Mid Term I<br>End Term |
| 21 | Acceleration analysis Coriolis acceleration component | Get clear view about acceleration and coriolis component | Tutorial cum Lecture | 2302.3 | Class Quiz<br>Mid Term I<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 22,23 | Problem on acceleration of mechanism | Able to calculate acceleration | Tutorial cum Lecture | 2302.3 | Class Quiz<br>Mid Term I<br>End Term |
| 24 | Types of cam & followers | Introducing Cams | Lecture | 2302.4 | Class Quiz |
| | | and follower | | | Mid Term II<br>End Term |
| 25,26 | Derivatives, motions of the follower | Analyse the operation of cams and flower motion | Lecture | 2302.4 | Class Quiz<br>Mid Term II<br>End Term |
| 27 | Design cam profiles | Able to draw cam profile | Lecture | 2302.4 | Class Quiz<br>Mid Term II<br>End Term |
| 28,29 | problem on SHM, constant velocity cam profile | Practice of concept based numerical problems - IV | Tutorial cum Lecture | 2302.4 | Class Quiz<br>Mid Term II<br>End Term |
| 30 | problem on constant acceleration and cycloidal profile | Able to calculate different forces and speeds of different governor | Tutorial cum Lecture | 2302.4 | Class Quiz<br>Mid Term II<br>End Term |
| 31,32 | Inclined plane friction, Flat and collar friction | Analyse the friction | Lecture | 2302.6, 2302.2 | Class Quiz<br>Mid Term II<br>End Term |
| 33 | Friction clutch, Cone clutch | Introducing Clutch | Lecture | 2302.6, 2302.2 | Class Quiz<br>Mid Term II<br>End Term |
| 34 | Problems on clutch | Practice of concept based numerical problems - V | Tutorial cum Lecture | 2302.6 | Class Quiz<br>Mid Term II<br>End Term |
| 35 | Block or shoe brakes | Introducing brakes | Lecture | 2302.6 | Class Quiz<br>Mid Term II<br>End Term |
| 36 | Band and block brakes | Knowledge of different types of brakes | Tutorial cum Lecture | 2302.6, 2302.2 | Class Quiz<br>Mid Term II<br>End Term |
| 37,38 | Problems | Practice of concept based numerical problems - VI | Tutorial cum Lecture | 2302.6 | Class Quiz<br>Mid Term II<br>End Term |
| 39,40 | Types of gears | Introducing Gears | Lecture | 2302.5 | Class Quiz<br>End Term |
| 41 | Gear terminology | Understanding on gear terminology | Lecture | 2302.5 | Class Quiz<br>End Term |
| 42,43 | Law of gearing & gear tooth profile | Analyse the gear profile | Lecture | 2302.5 | Class Quiz<br>End Term |
| 44,45 | Minimum number of teeth to avoid interference | Able to minimize the interference | Lecture | 2302.5 | Class Quiz<br>End Term |
| 46 | Undercutting | Analyse the effects of interference and minimize it | Lecture | 2302.5 | Class Quiz<br>End Term |
| 47 | Arc and path of contact | Able to calculate path of contact | Tutorial cum Lecture | 2302.5 | Class Quiz<br>End Term |
| 48 | problems on gear terminology | Practice of concept based numerical problems - VII | Tutorial cum Lecture | 2302.5 | Class Quiz<br>End Term |
| 49 | Gear Train | Introducing Gear trains | Lecture | 2302.5 | Class Quiz<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 50,51 | Epicycle gear train | Able to understand best suited gear train like epicyclic | Lecture | 2302.5 | Class Quiz<br>End Term |
| 52,53 | Problems | Practice of concept based numerical problems - VIII | Tutorial cum Lecture | 2302.5 | Class Quiz<br>End Term |
| 54 | Differential gear box in automobile vehicle | Have understanding of working of differential | Lecture | 2302.6 | Class Quiz<br>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 |
| ME2302.1 | Understand the concepts of linkage and their relative motion. | 3 | 2 | | | | 1 | 1 | | | | | 2 | | | |
| ME2302.2 | Co-relate all the mechanism with real life machines. | 3 | 1 | 1 | | | 1 | | | | | | 1 | | | |
| ME2302.3 | Analyse the velocity and acceleration of different mechanism. | 3 | 2 | 1 | 1 | | | | | | | | | | | |
| ME2302.4 | Create specific cam profile for specific follower movement. | 3 | 2 | 1 | 2 | | | | | | | | | 1 | | |
| ME2302.5 | Understand gear terminologies and various parameters related to gear motion such as path analysis. | 3 | 2 | 1 | | | | | | | | | 1 | | | |
| ME2302.6 | Evaluate the forces and motion of transmission devices like differential gear box and clutches. | 3 | 2 | 2 | | | | | | | | | 1 | 1 | | |

**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

Applied Thermodynamics| ME 2303 | 4 Credits | 3 0 0 1

Session: July 20 – Nov 20 | Faculty | Class: 2nd Year

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering, targeting students who wish to pursue research & development in industries or higher studies in field of Mechanical engineering. In this course we aimed to make the students familiar with the application of thermodynamics. Further to explain the Basic working principle involved Refrigeration, Air conditioning, compressors, thermodynamics relations and to explain effect compressibility and introduction to shock waves.

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

**[ME2303.1]** Apply different laws and basic concept of thermodynamics in daily life engineering applications.

**[ME2303.2]** Analyse the properties of refrigerant and refrigeration cycle

**[ME2303.3]** Comprehend the basic definitions and terminology of Psychrometry and Air conditioning.

**[ME2303.4]** Design of reciprocating machines as well as Impact of compressible fluids flow

**[ME2303.5]** Judge and apply the basic thermodynamic principles for design, operation and behavior involved in the development, production, procurement for employability.

**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.

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

### D. Assessment Rubrics:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | Quizzes and Assignments | 30 |
| 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/ (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

Property relationships for pure substances and Mixtures. Thermodynamic Relations: Some mathematical theorems, Maxwell's equations, Tds equations, Difference in heat capacities, ratio of heat capacities, energy equation, Joule- Thomson effect. Clausius- Clapeyron equation, Evaluation of thermodynamic properties from an equation of state. Helmoltz and Gibbs functions; Enthalpy, entropy, internal energy, and specific heat relations; Clausius-Clapeyron's equation; Applications to ideal and real gases. Joule-Thomson coefficient. Refrigeration Cycle: Basic concepts of refrigeration cycle, Vapour compression refrigeration cycle: components, performance and capacity of the plant, Effect of change in operating conditions on performance of vapour compression cycle, Refrigerant: Designation of chemical formula, selection of refrigerant, chemical properties, physical properties. Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. Multi-stage compressor, saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression. Compressible Flows and Steam Nozzles: Compressible Flows: Velocity of pressure pulse in a fluid, stagnation properties, one dimensional steady isentropic flow, critical properties-choking in isentropic flow, normal shocks, adiabatic flow with friction and without friction, numerical problems. Steam nozzles: Flow of steam through nozzles, shape of nozzles, effect of friction, critical pressure ratio, supersaturated flow. Psychometry: Atmospheric air and Psychometric properties; Dry bulb temperature, wet bulb temperature, dew point temperature; partial pressures, specific and relative humidity and the relation between the two. Enthalpy and adiabatic saturation temperature. Construction and use of psychrometric chart. Analysis of various processes; heating, cooling, dehumidifying and humidifying. Adiabatic mixing of stream of moist air. Summer and winter air-conditioning.

**F. Text Books:**

1. P.K. Nag, Basic and Applied Thermodynamics, Tata McGraw Hills, 8th Edition, 2006.

2. Estop and Mc Conkey, Applied Thermodynamics for Engineering Technologies, Longman, 5th Edition, 2002.

**G. Reference Books:**

1. Y.A. Cengel and M.A. Boles, Thermodynamics: An Engineering Approach, McGraw Hill, 5th Edition, 2005.
2. C. Borgankke and R.E. Sontag, Fundamental of Thermodynamics, Wiley, 8th Edition, 2009.

## H. Lecture Plan:

| Lecture No. | Topics | Mode of Delivery | Corresponding CO | Mode of Assesing the outcomes |
|---|---|---|---|---|
| 1 | Revision of basic Thermodynamics | Lecture | ME 2303.1 | Class Quiz<br>Mid term-1<br>End Term |
| 2 | Mathematical Theorem, Maxwell's equations, Tds equations | Lecture | ME 2303.1 | |
| 3 | Tds equations, difference and ratio of heat capacities | Lecture | ME 2303.1 | |
| 4 | Problems on maxwell and Tds | Lecture/Tutorial | ME 2303.1 | |
| 5 | Energy and enthalpy equations, Joule - Thomson coefficient | Lecture | ME 2303.1 | |
| 6 | Joule –Thomson effect, Inversion curve | Lecture | ME 2303.1 | |
| 7 | Problems on energy, enthalpy | Lecture | ME 2303.1 | |
| 8 | Problems on Joule-Thomson | Lecture/Tutorial | ME 2303.1 | |
| 9 | Clausius - Clapeyron Equation | Lecture | ME 2303.1 | |
| 10 | Evaluation of thermodynamic properties from an equation of state, Gibbs and Helmholtz functions | Lecture | ME 2303.1 | |
| 11 | Problems on Clausius-Clapeyron | Lecture/Tutorial | ME 2303.1 | |
| 12 | Basic concepts of Refrigeration cycles | Lecture | ME 2303.2 | |
| 13 | Vapour Compression Refrigeration cycle components and working | Lecture | ME 2303.2 | |
| 14 | Performance and capacity of VCRS | Lecture | ME 2303.2 | |
| 15 | Effect of change in operating conditions of VCRS | Lecture | ME 2303.2 | |
| 16 | Designation of chemical formula of refrigerants | Lecture | ME 2303.2 | |
| 17 | Refrigerant and its selection criteria, chemical and physical properties | Lecture | ME 2303.2 | |
| 18 | Problems on VCRS | Lecture/Tutorial | ME 2303.2 | |
| 19 | Compressors and its classifications | Lecture | ME 2303.4 | Class Quiz<br>Mid Term-2<br>End Term |
| 20 | Operation of Single Stage Reciprocating Compressor | Lecture | ME 2303.4 | |
| 21 | Work input, Effect of clearance | Lecture | ME 2303.4 | |
| 22 | Volumetric, Adiabatic, isothermal and mechanical efficiencies, | Lecture | ME 2303.4 | |

| | | | | |
|---|---|---|---|---|
| 23 | Problems based on Single stage reciprocating compressors | Lecture/Tutorial | ME 2303.4 | |
| 24 | Multistage compressor, Saving in work, optimum intermediate pressure, Intercooling | Lecture | ME 2303.4 | |
| 25 | Intercooling, Minimum work for compression, Problems | Lecture | ME 2303.4 | Class Quiz<br>Mid Term- 2<br>End Term |
| 26 | Problems on multistage and intercooling | Lecture/Tutorial | ME 2303.4 | |
| 27 | Psychrometry, Introduction and properties: DBT, WBT, DPT | Lecture | ME 2303.3 | |
| 28 | Partial pressure, specific humidity, relative humidity, Wet bulb depression | Lecture | ME 2303.3 | |
| 29 | Enthalpy, Adiabatic Saturation Temperature, Problems | Lecture | ME 2303.3 | |
| 30 | Problems on psychrometry properties | Lecture/Tutorial | ME 2303.3 | |
| 31 | Construction and use of Psychrometric Chart | Lecture | ME 2303.3 | |
| 32 | Problems on psychrometric chart | Lecture | ME 2303.3 | |
| 33 | Air conditioning introduction and various Processes | Lecture | ME 2303.3 | |
| 34 | Heating, Cooling, Humidification, Dehumidification | Lecture | ME 2303.3 | |
| 35 | Heating and Humidification, Heating and Dehumidification | Lecture | ME 2303.3 | |
| 36 | Cooling and Humidification, Cooling and dehumidification | Lecture | ME 2303.3 | |
| 37 | Problems on air conditioning processes | Lecture/Tutorial | ME 2303.3 | Class Quiz<br>End Term |
| 38 | Adiabatic Mixing of stream of moist air, Problems | Lecture | ME 2303.3 | |
| 39 | Summer and Winter Air conditioning | Lecture | ME 2303.3 | |
| 40 | Compressible flow introduction, application and importance | Lecture | ME 2303.4 | |
| 41 | Velocity of pressure pulse in a fluid | Lecture | ME 2303.4 | |
| 42 | One dimensional steady Isentropic flow, Stagnation state | Lecture | ME 2303.4 | |
| 43 | Isentropic converging – diverging flow in cross-section, Isentropic table | Lecture | ME 2303.5 | |
| 44 | Problems on sonic velocity | Lecture/Tutorial | ME 2303.5 | |
| 45 | Critical Properties-chocking in isentropic flow | Lecture | ME 2303.5 | |

| | | | | |
|---|---|---|---|---|
| 46 | Normal Shock, Nozzles, shape of nozzles, critical Pressure ratio | Self Study | ME 2303.5 | |
| 47 | Supersaturated flow | Self Study | ME 2303.5 | |
| 48 | Review | Lecture | | |

## 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 |
| **ME2303.1** | Apply different laws and basic concept of thermodynamics in daily life engineering applications | 3 | 2 | | | | | | | | | | 2 | | | |
| **ME2303.2** | Analyse the properties of refrigerant and refrigeration cycle | | 3 | | | | | | | | | | | | | 1 |
| **ME2303.3** | Comprehend the basic definitions and terminology of psychrometry and air conditioning | 2 | 2 | | | | | | | | | | | | | |
| **ME2303.4** | Design of Reciprocating Machine as well as impact of compressible fluid flows | | 3 | 2 | | | | | | | | | | 3 | | |
| **ME2303.5** | Judge and apply the basic thermodynamic principles for design, operation and behaviour involved in the development, production, Procurement for employability. | | | 2 | | 2 | | | | | | | | 2 | | |

**0- No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment**

# MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

Strength of Material | ME 2304 | 3 Credits | 3 0 0 3

Session: July'19 – Nov'19 | Faculty: Dr.Dhaneshwar Mishra, Dr.Vimal Pathak and Ravinder Jhorar | Class: B.Tech Semester III

**Introduction**:

This course is offered by Dept. of Mechanical Engineering for 3rd Semester students. The aim of this course is to provide understandings on the material's behaviour against the external loadings in various types of structures, components and engineering systems. The contents of the course are designed in such a fashion so that students can prepare themselves in designing various mechanical and structural components along with the material selection process for these components and structures.

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

**[ME2304.1].** Draw and understand Shear Force and bending moment diagram for different types of beams under given constraints.

**[ME2304.2].** Understand stress, strain, strain energy, principal stresses, strains and determine their intensity on different structure under given constraints.

**[ME2304.3].** Analyze angular deflection and power transmission capacity in different cross section of shaft.

**[ME2304.4].** Analyze bending stress and transverse shear stress distribution in different types of sections.

**[ME2304.5].** Analyze failure of column and strut by analyzing different end conditions.

**[ME2304.6].** Analyze transverse deflection of beams and shaft under static loading.

## B. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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

**[PO.2] Problem Analysis**: Identify, formulate, research literature and analyse 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 understanding 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.

**PROGRAMME SPECIFIC OUTCOMES:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book/Open with only Lecture Notes/PPT allowed) | 15 |
| | Sessional Exam II (Close Book/Open with only Lecture Notes/PPT allowed) | 15 |
| | Three Quizzes<br>Five Assignments | 15<br>15 |
| End Term Exam (Summative) | End Term Exam (Close Book/Open with only Lecture Notes/PPT allowed) | 40 |
| | Total | 100 |

- In addition to the above mentioned assessment scheme, the faculty in the individual section can have his/her own assessments based on surprise quizzes and tests or any other form he/she wants.
- The faculty can allot the internal marks (30) accordingly.
- The assignments should be submitted on time.
- Failure of submission on the given deadline will lead to loss of the marks allotted for the particular assignment. (1 day late: 20%, 2 days late: 50%, More than 2 days late: 100%)

| | |
|---|---|
| Attendance (Formative) | • The students have to attend 100% classes.<br>• A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination.<br>• The allowance of 25% includes all types of leaves including medical leaves.<br>• No any other excuses will be acceptable in case the students not being able to attend 75% of the total classes. |
| 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. |
| Discipline in Class | • The students are requested to maintain the decorum of the class so that the effective teaching learning can take place<br>• They will always be encouraged to ask questions, participate in discussions but the students should refrain from any activities that can disturb their peers and the faculty instructor.<br>• Use of Mobile Phones are strictly prohibited during the class period. They should always be switched off during the class period. Any body found violating this will be penalized heavily. |

## E. Syllabus:

Simple Stress and Strain-Properties of materials, Types of stress and strains, Stress-strain relationship, Deformation under axial loading, Thermal stress, Strain energy.Analysis of stresses in 2D-Biaxial state of stresses, stresses on inclined planes, Principal plane and stresses on principal plane, Mohr's circle of biaxial stresses, Maximum shear stress.Beams-Types of loads, Supports, Shear force and bending moment diagrams, Stress in beams.Torsion-Torsion equation, Shear stress distribution in a shaft, Torsion in solid, hollow and stepped shafts.Beam Deflection-Elastic curve of neutral axis of the beam, beam deflection and its slope, Macaulay's method-Columns-Equivalent length of a column, Euler's equation, Slenderness ratio, Rankine formulae-Thick and Thin CylindersThick and thin cylindrical shells, Spherical shells, Deformations in thick and thin cylindrical shells

## F. Text Books:

T1. F. P. Beer, E. R. Johnston Jr., J. T. Dewolf, and D. F. Mazurek, Mechanics of Materials, 6th Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2013.

T2. R. C. Hibler, Mechanics of Materials, Pearson, 2014, ISBN: 978:93-325-1860-5.

## G. References:

R1. E.P Popov, "Mechanics of Materials", S.I. Version, PHI, 1993.

R2. Dr. B. C. Punamia, A. K. Jain, and A. K. Jain, SMTS-I Strength of Materials, Laxmi Publication Pvt. Ltd., 10th Edition, 2011.

**H. Lecture Plan:**

| Lecture S.no. | Portions to be covered | Mode of delivery | Corresponding CO | Mode of assessing the outcome |
|---|---|---|---|---|
| L1 | Introduction and significance of the course: Solid Mechanics | Lecture | **ME 2304.1** | ---------- |
| L2 | Properties of Materials: Strength, Stiffness and Stability, Stress and its type: Tensile, Compressive and Shear | Lecture, C& T | **ME 2304.1** | Class quiz/ Sessional Exam |
| L3 | Strain, Hooke's Law, Stress-strain(σ-ϵ) curve | Lecture, C&T | **ME 2304.1** | Class Quiz/ Sessional Exam |
| L4 | Deformation of simple and compound bars under axial load | Lecture, C&T | **ME 2304.1** | Quiz, Sessional Exam |
| L5 | Numerical practices on deformation under axial load | Activity | **ME 2304.1** | Class test/ Sessional Exam |
| L6 | Thermal Stressandstraincalculation for composite beam | Lecture, C&T | **ME 2304.1** | Class quiz/ Sessional Exam |
| L7 | Numerical practices on thermal stress-strain | Lecture, C&T, Activity | **ME 2304.1** | Class test, Sessional Exam |
| T1 | Elastic constants, Strain energy and unit strain energy | Lecture, C&T | **ME 2304.1** | Class quiz/ Sessional Exam |
| L8 | Numerical practices | Activity | **ME 2304.1** | Quiz/ Sessional Exam |
| L9 | Loads and Stresses: Types of beams, supports and loads, Shear force diagram(SFD) and Bending Moment diagram(BMD) | Lecture, C&T | **ME 2304.2** | Class Quiz/ Sessional Exam |
| L10 | Cantilever Beam and related Numerical Problems | Lecture, C&T | **ME 2304.2** | Class quiz/ Sessional Exam |
| L11 | Simply Supported Beam and related Numerical Problems | Flipped Classroom | **ME 2304.2** | Class quiz, Sessional Exam |
| L12 | Overhanging Beam and related Numerical Problems | Flipped Classroom | **ME 2304.2** | Class quiz/ Sessional Exam |
| L13 | SFD and BMD Numerical Problems: Assignment-1 | Discussion | **ME 2304.2** | Assignment |
| L14 | Theory of Simple bending Stress, Stress variation along the length and in the beam section | Lecture, C&T | **ME 2304.2** | Quiz/ Sessional Exam |
| L15 | Numerical Problems on pure bending stress | Flipped Classroom | **ME 2304.2** | Class Quiz/ Sessional Exam |
| L16 | Effect of shape of beam section on stress induced, Shear stresses in beams, Shear flow | Lecture, C&T | **ME 2304.2** | Class test |
| L17 | Numerical Problems on shear stress in beams | Flipped Classroom | **ME 2304.2** | Quiz/ Sessional Exam |
| L18 | Torsion of circular bars, Shear stress distribution | Lecture, C&T | **ME 2304.3** | Quiz/ Sessional Exam |
| L19 | Numerical Practices | Lecture, C&T | **ME 2304.3** | Class quiz/ Sessional Exam |
| L20 | Bars of solid and hollow circular section, Stepped shaft | Flipped Classroom | **ME 2304.3** | Sessional exam |

| | | | | |
|---|---|---|---|---|
| L21 | Numerical Practices | Flipped Classroom | **ME 2304.3** | Quiz/ Sessional Exam |
| L22 | Twist and torsion stiffness, Fixed and simply supported beams, | Lecture, C&T | **ME 2304.3** | Class quiz/ Sessional Exam |
| L23 | Numerical Practices | Flipped Classroom | **ME 2304.3** | Quiz/ Sessional Exam |
| L24 | Elastic curve of neutral axis of the beam under normal loads | Lecture, C&T | **ME 2304.2** | Class Quiz/ Sessional Exam |
| L25 | Numerical Practices | Flipped Classroom | **ME 2304.2** | Quiz/ Sessional Exam |
| L26 | Beam deflection and its slope, Macaulay's Method | Lecture, C&T | **ME 2304.2** | Sessional Exam |
| L27 | Numerical Practices on various types of beams | Flipped Classroom | **ME 2304.2** | Sessional Exam |
| L28 | Columns , End conditions, Equivalent length of a column | Lecture, C&T | **ME 2304.4** | Quiz/ Sessional Exam |
| L29 | Numerical Practices | Lecture, C&T | **ME 2304.4** | Class quiz/ Sessional Exam |
| L30 | Euler equation, Slendernessratio and numerical practices | Activity | **ME 2304.4** | Sessional Exam |
| L31 | Rankine formulae and numerical Practices: Assignment-2 | Discussion | **ME 2304.4** | Assignment |
| L32 | Introduction to analysis of stresses in two dimensions | Lecture, C&T | **ME 2304.6** | Quiz/ Sessional Exam |
| L33 | Biaxial state of stresses | Flipped Classroom | **ME 2304.6** | Class quiz/ Sessional Exam |
| L34 | Numerical practices | Activity | **ME 2304.6** | Quiz/ Sessional Exam |
| L35 | Thick and thin cylindrical shells | Lecture, C&T | **ME 2304.5** | End term Exam |
| L36 | Numerical Practices | Flipped Classroom | **ME 2304.5** | Quiz/ End term Exam |
| L37 | Deformations, Biaxial stresses at a point | Lecture, C&T | **ME 2304.6** | Class quiz/ End term Exam |
| L38 | Numerical Practices | Flipped Classroom | **ME 2304.6** | Quiz/ End term Exam |
| L39 | Stresses on inclined plane | Lecture, C&T | **ME 2304.6** | Class quiz/ End term Exam |
| L40 | Principal planes and stresses | Lecture, C&T | **ME 2304.6** | Class test, End term Exam |
| L41 | Mohr's circle for biaxial stresses: Assignment-3 | Lecture, Activity | **ME 2304.6** | Discussion/ End term Exam |
| L42 | Critical Problem on biaxial stresses | Flipped Classroom | **ME 2304.6** | End term Exam |

**I. 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 |
| ME2304.1 | Draw and understand Shear Force and bending moment diagram for different types of beams under given constraints. | 3 | 2 | 3 | | | 2 | | | | | | 1 | | | |
| ME2304.2 | Understand stress, strain, strain energy, principal stresses, strains and determine their intensity on different structure under given constraints. | 3 | 2 | 3 | | | | | | | | | 1 | 1 | | |
| ME2304.3 | Analyze angular deflection and power transmission capacity in different cross section of shaft. | 3 | 2 | 3 | | | | | | | | | 1 | 1 | | |
| ME2304.4 | Analyze transverse deflection of beams and shaft under static loading. | 3 | 2 | 3 | | | | | | | | | 1 | 1 | | |
| ME2304.5 | Analyze failure of column and strut by analyzing different end conditions. | 3 | 2 | 3 | | | | | | | | | 1 | 1 | | |
| ME2304.6 | Analyze transverse deflection of beams and shaft under static loading. | 3 | 2 | 3 | | | | | | | | | 1 | 1 | | |

**5- 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

Computer Aided Machine Drawing Lab | ME 2331 | 2 Credits | 0 0 4 2

Session: July 20 – November 20 | Faculty: Dr. Ravi Kumar Gupta;

Class: IInd Year Semester III

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering, targeting students who wish to pursue product development assignment in industries, research & development in industries or higher studies in field of Mechanical engineering as design specialist. In this course, mainly it is aimed to provide students with the writing and reading principles of "Machine Drawing", which is a graphical universal language used in technical world for describing the shape and size of an object via supplying orthographic views and/ or solid models associated with all the necessary dimensions, associated tolerances and annotations created in a computer aided design (CAD) environment.

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

**[ME2331.1]** Modelling two-dimensional sketches, visualization in CAD environment.

**[ME2331.2]** Skill in digital modelling of various types of machine parts and enhance the employability in product development.

**[ME2331.3]** Draw the orthographic views of an object in CAD & production of engineering drawings.

**[ME2331.4]** Read the given different views of 3D model and create its CAD model and enhance the employability in product development.

**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.

**[PSO.1].** Model and analyse mechanical engineering components using advanced software.

**[PSO.2].** Analyse performance of I. C. engines attributed to alternate fuels.

**[PSO.3].** Synthesize advance materials for mechanical engineering applications.

## D. Assessment Rubrics:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Lab work and Assignments | 60 % |
| End Term Exam (Summative) | End semester examination | 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

Introduction to design process, orthographic projection free hand sketching, introduction of creo 2.0. Demonstration of creo sketcher workbench. Demonstration of part design, Screw jack body, Spindle and cup, Nut, washer, set screw and tommy bar, Plumber block body, cap and nut, Brasses and Bolts. Demonstration of Sectioning, BoM, limits, fits and tolerances, dimensional and geometric tolerances. couplings. Demonstration of Assembly workbench, drafting. Screw Jack Assembly and drafting. Plumber Block Assembly and drafting, Projects.

## F. Text Book:

T1. K.L. Narayana, Machine Drawing, Wiley Eastern, 2nd Edition, 2009.
T2. CREO 2.0 online web Tutorials.

## G. Reference Book:

R1. CAD/CAM Principles and Applications, P.N. Rao, Mc Graw Hill Education.
R2. CAD/CAM: Computer-Aided Design and Manufacturing, M. Groover and E. Zimmers, PearsonIN.
R3. Product Design and Development, Ulrich and Eppinger, Mc Graw Hill Education.

**H. Lecture Plan:**

| Lec No | **Topics** | **Session Objective** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | Introduction to design process, orthographic projection, free hand sketching, dimension. | Know the basics of the course and understand its applications | Lecture | ME2331.1 | 2 Assignments and End-Term Exam |
| 2 | **Module 1:** Demonstration of CREO sketcher workbench, practice problems | Know the sketcher workbench | Lab demonstration | ME2331.1 | |
| 3 | Assignment 1, Assignment 2: Based on CREO sketcher workbench. | Practice on CAD modelling tool | Lab practice | ME2331.1 | |
| 4 & 5 | **Module 2:** Demonstration of CREO part design workbench. practice problems | Know the part design workbench | Lab demonstration | ME2331.1 ME2331.2 | 7 Assignments and End-Term Exam |
| 6 | Assignment 3, Assignment 4: Based on part Design. | Practice on CAD modelling tool | Lab practice | ME2331.2 | |
| 7 | Assignment 5: Spindle and cup | Practice on CAD modelling tool | Lab practice | ME2331.2 | |
| 8 | Assignment 6: Nut, washer, set screw and tommy bar | Practice on CAD modelling tool | Lab practice | ME2331.2 | |
| 9 | Assignment 7: Plumber block body | Practice on CAD modelling tool | Lab practice | ME2331.2 | |
| 10 | Assignment 8: Cap and Nut | Practice on CAD modelling tool | Lab practice | ME2331.2 | |
| 11 | Assignment 9: Brasses and Bolts | Practice on CAD modelling tool | Lab practice | ME2331.2 | |
| 12 & 13 | **Module 3:** Demonstration of Sectioning, BoM, limits, fits and tolerances, dimensional and geometric tolerances. Practice problems | Know the Sectioning, BoM, limits, fits and tolerances, dimensional and geometric tolerances | Lab demonstration; Lab practice | ME2331.2 ME2331.3 | 1 Assignment and End-Term Exam |
| 14 | Assignment 10: Part modelling of Machine component & Sectioning. Screw jack body | Practice on CAD modelling tool | Lab practice | ME2331.2 ME2331.3 | |
| 15 | **Module 4:** Demonstration of Assembly workbench, drafting | Know the Assembly and drafting | Lab demonstration | ME2331.2 ME2331.3 | 3 Assignments and End-Term Exam |
| 16 | Assignment 11: Assembly design of Screw Jack and Drafting. | Practice on CAD modelling tool | Lab practice | ME2331.2 ME2331.3 | |
| 17 | Assignment 12: Assembly design of Stop valve and Drafting. | Practice on CAD modelling tool | Lab practice | ME2331.2 ME2331.3 | |
| 18 | Assignment 13: Plumber Block Assembly and drafting | Practice on CAD modelling tool | | ME2331.2 ME2331.3 | |
| 19 | **Module 5:** Demonstration of CREO production Drawing. | Know the production Drawing | Lab demonstration | ME2331.3 ME2331.4 | 1 Assignment, Presentation |

| | | | | | |
|---|---|---|---|---|---|
| 20 | Assignment 14: Preparation of Bill of material, limits and tolerance for screw jack or Stop valve or Plumber Block. | Practice on CAD modelling tool | Lab practice | ME2331.2<br>ME2331.3<br>ME2331.4 | and End-Term Exam |
| 21, 22 & 23 | Project / Practice Exercise | Practice on CAD modelling tool/ presentations | Lab practice/ presentation | ME2331.1<br>ME2331.2<br>ME2331.3<br>ME2331.4 | |
| 24 | Exams and Evaluations | Lab exam | Lab exam | | |

## 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 |
| **ME2331.1** | Modelling two-dimensional sketches, visualization in CAD environment. | 1 | | | | 3 | | | | | | | | 3 | | |
| **ME2331.2** | Skill in digital modelling of various types of machine parts and enhance the employability in product development. | 1 | 2 | 2 | | 3 | | | | | 3 | | 2 | 3 | | |
| **ME2331.3** | Draw the orthographic views of an object in CAD & production of engineering drawings. | 1 | | | | 3 | | | | | | | | 3 | | |
| **ME2331.4** | Read the given different views of 3D model and create its CAD model and enhance the employability in product development. | 1 | 1 | | | 3 | | | | | | | | 3 | | |

**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

Strength of Material Lab| ME 2131 | 3 Credits | 0 0 2 1

Session: Aug 20 – Dec 20 | Faculty: S. Dewangan | Class: B.Tech III Sem

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering as a laboratory, targeting students who wish to pursue research & development in industries or higher studies in the field of Applied mechanics and material testing. This course includes the calculation and analysis of various mechanical properties of the materials. These properties are tensile strength, compressive strength, modulus of elasticity, hardness, toughness, etc.

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

**[ME 2131.1].** To find the hardness of material by using various indentation methods.

**[ME 2131.2].** To analyse the toughness of the material by the virtue of energy stored by the material before fracturing.

**[ME 2131.3].** Assessment of strength of material by using tension, compression test and bending test on UTM.

**[ME 2131.4].** To find the torque and shear strength of the material by the virtue of twisting and shearing off the material by an external agency.

**[ME 2131.5].** Measurement of stress due to bending by using strain gauge.

**[ME 2131.6].** know about the working of fatigue testing machine.

**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].** Model and analyse of Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Laboratory Sessions | 60 |
| End Term Assesment (Summative) | Lab Exam Performance | 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 Practical End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a lab session will have to report to the teacher about the absence. The missed experiment can be performed as a makeup experiment in the next lab session or anytime before the laboratory exam | |
| Laboratory Guidelines | Students are expected to maintain an observation book and a laboratory record notebook. The experimental data should be noted in the observation book on the day of performance and the same should be transferred to the record notebook before the next lab. No students are allowed to enter the lab without the observation book and record book and attendance will be marked absent | |

**E. Syllabus**

Izod and Charpy Impact testing; Rockwell Hardness Testing; Vicker's Hardness Test; Brinell Hardness Testing; Torsion Testing; Tensile Testing; Compression Testing; Shear Testing; Bending Test on UTM; Measurement of stress due to bending using strain gauges, Study of Fatigue Testing Machine.

**References:**

1. R. Subramanian, Strength of Material, Oxford Univ. Press, 2nd Edition, 2010.
2. A.V.K Suryanarayan, "Testing of Materials" PHI, 2nd Edition, 1990.
Reference Book:
1. Technical Teachers, Training Institute, Lab Manual of Strength of Materials, oxford Univ. press, 1983.

**F. Lecture Plan:**

| Lab No | **Name of the Experiment** | **Experiment Outcome** | **Type of Expt** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | Izod and Charpy Impact testing; | To acquaint and clear teachers expectations and understand student expectations | Hands On | ME 2131.2 | Observational data, viva-voce |
| 2 | Rockwell Hardness Testing; | To acquaint and clear teachers expectations and understand student expectations | Hands On | ME 2131.1 | Observational Data, Viva-Voce |
| 3 | Vicker's Hardness Test; | To acquaint and clear teachers expectations and understand student expectations | Hands on | ME 2131.1 | Observational Data, Viva-Voce |
| 4 | Brinell Hardness Testing; | To acquaint and clear teachers expectations and understand student expectations | Hands On | ME 2131.1 | Observational Data, Viva-Voce |
| 5 | Torsion Testing; | To acquaint and clear teachers expectations and understand student expectations | Hands On | ME 2131.4 | Observational Data, Viva-Voce |
| 6 | Tensile Testing; | To acquaint and clear teachers expectations and understand student expectations | Hands On | ME 2131.3 | Observational Data, Viva-Voce |
| 7 | Compression Testing; | To acquaint and clear teachers expectations and understand student expectations | Hands On | ME 2131.3 | Observational Data, Viva-Voce |
| 8 | Shear Testing; | To acquaint and clear teachers expectations and understand student expectations | Hands On | ME 2131.4 | Observational Data, Viva-Voce |
| 9 | Bending Test on UTM; | To acquaint and clear teachers expectations and understand student expectations | Hands On | ME 2131.3 | Observational Data, Viva-Voce |
| 10 | Measurement of stress due to bending using strain gauges | To acquaint and clear teachers expectations and understand student expectations | Hands On | ME 2131.5 | Observational Data, Viva-Voce |
| 11 | Study of Fatigue Testing Machine. | To acquaint and clear teachers expectations and understand student expectations | Demo | ME 2131.6 | Observational Data, Viva-Voce |

**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 3 |
| [ME 2131.1] | To find the hardness of material by using various indentation methods. | 3 | | | | 2 | | | | | | | | | | 2 |
| [ME 2131.2] | To analyse the toughness of the material by the virtue of energy stored by the material before fracturing. | 2 | | | | 1 | | | | | | | | | | 1 |
| [ME 2131.3] | Assessment of strength of material by using tension, compression test and bending test on UTM. | | | | | 2 | | | | | | | | | | 3 |
| [ME 2131.4] | To find the torque and shear strength of the material by the virtue of twisting and shearing off the material by an external agency. | 3 | | | 1 | | | | | | | | | | | 1 |
| [ME 2131.5] | Measurement of stress due to bending by using strain gauge. | 1 | | | 1 | 2 | | | | | | | | | | 1 |
| [ME 2131.6] | know about the working of fatigue testing machine. | 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

Fluid Mechanics and Hydraulic Machinery | ME 2401 | 4 Credits | 4 0 0 4

Session: Jan'21 – April'21 | Faculty: Dr. Dhaneshwar Mishra, Dr. Ravi Kumar Sharma, and Mr. Ravinder Jhorar|

Class: 4th Semester

**Introduction**:

This course is offered by Dept. of Mechanical Engineering for 4th Semester students. The aim of this course is to provide understandings on the fluid, behaviour of fluid flow, governing laws, and different machines whose working is based on the fluid flow. The course covers the behaviour of fluid at rest and in motion. Students are expected to have background knowledge of Engineering Mechanics and Basic Physics.

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

**[ME 2401.1]** Describe the properties and classification of fluid and depict the effect of these properties on fluid in motion and at rest.
**[ME 2401.2]** Establish understanding about fluid pressure and flow rate measuring devices.
**[ME 2401.3]** Analyse the stability of floating and submerged bodies and distinguish between various types of flows.
**[ME 2401.4]** Modify different operating parameters to enhance the performance of hydraulic machines.
**[ME 2401.5]** Recognize different applications of fluid mechanics and fluid flow through different cross- sections.
**[ME 2401.6]** Fabricate devices which exhibit the principles of fluid mechanics and evaluate their performance.

## B. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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

**[PO.2] Problem Analysis**: Identify, formulate, research literature and analyse 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.

### C. Programme Specific Outcomes:

**[PSO.1].** Model and analyse of Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| | Sessional Exam I (Close Book) | 15 |

| | | |
|---|---|---|
| | Sessional Exam II (Close Book) | 15 |

| | | |
|---|---|---|
| Internal Assessment (Summative) | Three Quizzes<br>Three Assignments | 15<br>15 |
| End Term Exam (Summative) | End Term Exam (Close Book/Open with only Lecture Notes/PPT allowed) | 40 |
| | Total | 100 |

- In addition to the above mentioned assessment scheme, the faculty in the individual section can have his/her own assessments based on surprise quizzes and tests or any other form he/she wants.
- The faculty can allot the internal marks (30) accordingly.
- The assignments should be submitted on time.
- Failure of submission on the given deadline will lead to loss of the marks allotted for the particular assignment. (1 day late: 20%, 2 days late: 50%, More than 2 days late: 100%)

| | |
|---|---|
| Attendance (Formative) | • The students have to attend 100% classes.<br>• A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination.<br>• The allowance of 25% includes all types of leaves including medical leaves.<br>• No any other excuses will be acceptable in case the students not being able to attend 75% of the total classes. |
| 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. |
| Discipline in Class | • The students are requested to maintain the decorum of the class so that the effective teaching learning can take place<br>• They will always be encouraged to ask questions, participate in discussions but the students should refrain from any activities that can disturb their peers and the faculty instructor.<br>• Use of Mobile Phones are strictly prohibited during the class period. They should always be switched off during the class period. Any body found violating this will be penalized heavily. |

## D. Syllabus:

Properties of Fluids: - Introduction, Various properties, Newtonian and Non-Newtonian Fluids. Fluid Statics: Pressure and its measurement: Pressure gauge, Manometers, Pascal's law, Hydrostatic law: Forces on plane and curved surfaces, Centre of pressure; Buoyancy, equilibrium of submerged and floating bodies, metacentric height. Fluid Kinematics: Lagrangian and Eulerian description of fluid flow, Types of Fluid flow, Stream line, path line and streak lines, Continuity equation, Fluids subjected to Velocity and acceleration, vorticity, circulation, Stream function, Velocity Potential function, Cauchy Riemann equation. Fluid Dynamics: Euler's and Bernoulli's equation, Bernoulli's theorem, Applications of Bernoulli's equation, Vortex Motion: Free and Forced. Viscous flow: Reynold's Number, Darcy Weisbach equation, Laminar flow: circular pipe (Hagen Poiseuille's equation), Parallel Plates; Flow: Pipe flow, Friction factor, Minor and major losses in pipe, Boundary layer concept, Boundary layer separation. Dimensional Analysis: Basic and derived quantities, similitude and dimensional analysis, Buckingham $\pi$ –theorem, non-dimensional parameters and its significance. Hydraulic Machines: Rotating Elements: - Classification and efficiencies of turbines, performance curve. Reciprocating Pump: - Working principle, discharge, work done, efficiency, slip. Centrifugal Pump: - Working principle, indicator diagram, components, Efficiency, Pump characteristics, multistage centrifugal pump.

**Text Books:**

1. F.M. White, Fluid Mechanics, Tata McGraw Hills Pub., 7th Edition, 2011.

2. P.N. Modi and Seth, Fluid Mechanics, Standard Book House Pub.,18th Edition, 2011.

**Reference Books:**

1.Y.A. Cengel, J.M. Cimbala, Fluid Mechanics, McGraw-Hill Higher Education, 3rd Edition, 2014.

2. A. K. Jain, Fluid Mechanics Including Hydraulic Machines, Khanna Publication, 12th Edition, 2010.

**E. Lecture Plan:**

| Lec. No | **Topics** | **Session Outcome** | **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 | NA |
| 2 | Properties of Fluids, Types of fluids and Newton's law of viscosity | Understand working knowledge of basic properties of fluid and consequences of frictional effects it causes in fluid flow | Lecture | 2401.1 | In Class Quiz ( Not Accounted) |
| 3 | Numerical based on Newton's law of viscosity | Analytically find out the shear stress/ coefficient of viscosity/ rate of change of velocity with distance | Lecture | 2401.2 | In Class Quiz<br>End Term |
| 4 | Vapour pressure, Surface Tension and Capillarity | Recall the concept of surface tension, capillarity and their effects | Lecture | 2401.2 | Home Assignment<br>End Term |
| 5 | Numerical on Surface Tension and Capillarity Vapour pressure, Surface Tension and Capillarity | Calculate the capillary rise and fall in tubes due to surface tension effects | Lecture | 2401.3 | In Class Quiz<br>End Term |
| 6 | Fluid Statics- Introduction | Recall the concept of fluid pressure and units of pressure | Lecture | 2401.3 | Class Quiz<br>Mid Term I<br>End Term |
| 7 | Fluid flow measurements- Manometers | Understand the working of a manometer | Lecture | 2401.3 | Class Quiz<br>Mid Term 1<br>End term |
| 8 | Types of Manometers and Numerical on Manometers | Calculate the pressure using various kinds of manometer | Lecture | 2401.3 | Home Assignment<br>Class Quiz<br>Mid Term 1<br>End Term |

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| 9 | Hydrostatic forces on plane surfaces | Recall forces and moments exerted by fluid at rest on plane surface | Lecture | 2401.3 | Class Quiz<br>Mid Term 1<br>End Term |
| 10 | Hydrostatic forces on inclined and curved surfaces | Recall forces and moments exerted by fluid at rest on inclined and curved surfaces | Lecture | 2401.3 | Class Quiz<br>Mid Term I<br>End Term |
| 11 | Numerical on Hydrostatic forces on various surfaces | Calculate forces and moments exerted by fluid at rest on plane, inclined and curved surfaces | Lecture | 2401.4 | Class Quiz<br>End Term |
| 12 | Buoyancy and Floatation | Analyse the stability of floating and submerged bodies | Lecture | 2401.3 | Class Quiz<br>Mid Term II<br>End Term |
| 13 | Metacentric Height and derivation of its mathematical expression | Analyse the stability of floating and submerged bodies | Lecture | 2401.3 | Class Quiz<br>Mid Term II<br>End Term |
| 14 | Conditions of equilibrium for a floating and submerged body | Analyse the stability of floating and submerged bodies | Lecture | 2401.2 | Class Quiz<br>Mid Term II<br>End Term |
| 15 | Numerical on Buoyancy and Metacentric Height | Evaluate the buoyant force and metacentric height | Lecture | 2401.3 | Class Quiz<br>Mid Term II<br>End Term |
| 16 | Fluid Kinematics-Introduction and Types of flow | Describe the motion of fluid without considering the forces causing the motion, Distinguish between different flows | Lecture | 2401.3 | Class Quiz<br>End Term |
| 17 | Continuity Equation | Assumptions while deriving the continuity equation | Lecture | 2401.3 | Class Quiz<br>End Term |
| 18 | Numerical based on continuity equation | Calculate the dimension(s) of the pipeline | Lecture | 2401.2 | Class Quiz<br>End Term |
| 19 | Eulerian and Lagrangian approach with related numerical | Understand the role of material derivative in transforming between Lagrangian and Eulerian descriptions | Lecture | 2401.2 | Class Quiz<br>End Term |

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| 20 | Potential function and Stream Function | Describe the concept of potential and stream function | Lecture | 2401.2 | Class Quiz<br>End Term |
| 21 | Flow Net, Equipotential lines, Relation between Potential function and Stream Function | Mathematically analyse potential and stream function | Lecture | 2401.2 | Class Quiz<br>End term |
| 22 | Numerical on Potential function and Stream Function | Mathematically analyse potential and stream function | Lecture | 2401.2 | Class Quiz |
| 23 | Fluid Dynamics- Introduction | Apply the conservation of mass equation to balance the incoming and outgoing flow rates in a flow system | Lecture | 2401.2 | Class Quiz<br>Mid Term II<br>End Term |
| 24 | Euler's Equation and its derivation | Apply the conservation of mass equation to balance the incoming and outgoing flow rates in a flow system | Lecture | 2401.2 | Class Quiz<br>Mid Term II<br>End Term |
| 25 | Bernoulli's equation from Euler equation | Understand the use and limitations of Bernoulli's equation | Lecture | 2401.2 | Class Quiz<br>Mid Term II<br>End Term |
| 26 | Bernoulli's equation for the flow of incompressible fluid | Understand the use and limitations of Bernoulli's equation | Lecture | 2401.2 | Class Quiz<br>End Term |
| 27 | Bernoulli's equation for a real fluid | Understand the use and limitations of Bernoulli's equation | Lecture | 2401.2 | Class Quiz<br>End Term |
| 28 | Numerical based on Bernoulli's equation | Work with the energy equation expressed in terms of heads and use it to determine power output | Lecture | 2401.2 | Class Quiz<br>End Term |
| 29 | Practical Applications of Bernoulli's equation | Describe various applications of the equation | Lecture | 2401.2 | Class Quiz<br>End Term |
| 30 | Venturimeter and derivation of rate of flow equation | Understand the working principle of the device and apply energy balance to find flow rate | Lecture | 2401.2 | Class Quiz<br>End Term |

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|---|---|---|---|---|---|
| 31 | Numerical on Venturimeter | Determining unknown quantities in the equation | Lecture | 2401.3 | Class Quiz<br>End Term |
| 32 | Orifice meter and derivation of rate of flow equation | Understand the working principle of the device and apply energy balance to find flow rate | Lecture | 2401.3 | NA |
| 33 | Numerical on Orifice meter | Determining unknown quantities in the equation | Lecture | 2401.3 | End Term Theory |
| 34 | Pitot tube and related numerical | Understand the working principle of the device and its application | Lecture | 2401.3 | Class Quiz<br>End Term |
| 35 | V-notch and Rectangular notch | Describe fluid flow through different cross-sections | Lecture | 2401.3 | Class Quiz<br>End Term |
| 36 | Dimensional Analysis-Introduction | Dimensionally examine the various fluid parameters and equations | Lecture | 2401.3 | Class Quiz<br>End Term |
| 37 | Method of Dimensional analysis and Similitude | Dimensionally examine the various fluid parameters and equations | Lecture | 2401.3 | Class Quiz<br>End Term |
| 38 | Buckingham Pi-theorem | Dimensionally examine the various fluid parameters and equations | Lecture | 2401.4 | Class Quiz<br>End Term |
| 39 | Dimensionless numbers and their significance | Dimensionally examine the various fluid parameters and equations | Lecture | 2401.3 | NA |
| 40 | Laminar flow through circular pipe (Hagen Poiseuille's equation) | Derivation of final equation | Lecture | 2401.2 | Class Quiz<br>End Term |
| 41 | Laminar flow between fixed parallel plates | | Lecture | 2401.1 | Class Quiz<br>Mid Term I<br>End Term |
| 42 | Numerical on viscous fluid flow | | Lecture | 2401.2 | Class Quiz<br>Mid Term 1<br>End term |
| 43 | Flow Through Pipes- Darcy Weisbach equation | Recall fluid flow inside a pipe and the associated losses | Lecture | 2401.3 | Home Assignment<br>Class Quiz<br>Mid Term II |

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| | | | | | End Term |
| 44 | Chezy's formula and numerical | Recall fluid flow inside a pipe and the associated losses | Lecture | 2401.4 | Class Quiz<br>Mid Term 1I<br>End Term |
| 45 | Loss of Head and flow through pipes in series parallel and branched | Recall fluid flow inside a pipe and the associated losses | Lecture | 2401.3 | Class Quiz<br>Mid Term I<br>End Term |
| 46 | Power transmission through pipes condition of maximum efficiency | Determination of power transmitted through fluid | Lecture | 2401.4 | Class Quiz<br>End Term |
| 47 | Numerical on flow through pipes | Determination of power transmitted through fluid | Lecture | 2401.4 | Class Quiz<br>Mid Term II<br>End Term |
| 48 | Boundary layer concept- Laminar and Turbulent | Examine effect of interaction of fluid with solid surface and its consequences | Lecture | 2401.4 | Class Quiz<br>Mid Term II<br>End Term |
| 49 | Boundary layer separation | Examine effect of interaction of fluid with solid surface and its consequences | Lecture | 2401.5 | Class Quiz<br>Mid Term II<br>End Term |
| 50 | Boundary layer thickness, Momentum thickness, Energy thickness and based on numerical | Examine effect of interaction of fluid with solid surface and its consequences | Lecture | 2401.5 | Class Quiz<br>Mid Term II<br>End Term |
| 51 | Hydraulic Machines-Introduction | Recognize different hydraulic machines | Lecture | 2401.5 | Class Quiz<br>End Term |
| 52 | Turbines-Classification, Efficiency and Performance curve | Performance analysis of turbines | Lecture | 2401.5 | Class Quiz<br>End Term |
| 53 | Working principle, work done and efficiency of a Reciprocating pump | Describe Operating parameters | Lecture | 2401.5 | Class Quiz<br>End Term |
| 54 | Working principle, work done and efficiency of a Centrifugal pump | Describe Operating parameters | Lecture | 2401.5 | Class Quiz<br>End Term |
| 55 | Pump characteristics, Multistage centrifugal pump | Performance analysis of pumps | Lecture | 2401.5 | Class Quiz<br>End Term |

## F. 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 |
| **[ME 2401.1]** | Describe the properties and classification of fluid and depict the effect of these properties on fluid in motion and at rest. | 3 | | | | | | | 1 | | | | | | | |
| **[ME 2401.2]** | Establish understanding about fluid pressure and flow rate measuring devices. | | 2 | 2 | | | | | | | | 2 | | | | |
| **[ME 2401.3]** | Analyse the stability of floating and submerged bodies and distinguish between various types of flows. | | | | 2 | 2 | | | | | | | | | | |
| **[ME 2401.4]** | Modify different operating parameters to enhance the performance of hydraulic machines. | | | | | | 2 | | 2 | 3 | | | | | | |
| **[ME 2401.5]** | Recognize different applications of fluid mechanics and fluid flow through different cross-sections. | | | 1 | | | | | | 1 | 1 | | | | | |
| **[ME 2401.6]** | Fabricate devices which exhibit the principles of fluid | 3 | 2 | 2 | 2 | | | | | 2 | | | 1 | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mechanics and evaluate their performance. | | | | | | | | | | | | | | | |

**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

Dynamics of Machines| ME 2402 | 3 Credits | 3 0 0 3

Session: JAN 2021 – MAY 2021 | Faculty: Prof. N N Sharma/Dr.Ashish Sharma/Mr.Arpit Khandelwal

**Introduction:** This course is offered by Dept. of Mechanical Engineering which focuses on mainly static and dynamic forces. It deals with dynamic analysis of four bar linkage, turning moment of crank shaft, analysis of flywheel, balancing of various engines, analysis of governors and gyroscopic effects. This course gives an overview of fundamental working of brakes, clutches and various gear box. This course is pre-requisite for understanding in vibrations of machines.

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

**ME2402.1** Identify the static and dynamics forces in different kinematic mechanism.
**ME2402.2** Estimate the forces and their effects on four bar mechanism (IC engines).
**ME2402.3** Explain the computer based skill set to construct the turning moment diagram of crank shaft for different cycles and manipulate the diagram with the help of flywheel.
**ME2402.4** Compare the operations of different types of governors and their applications.
**ME2402.5** Analyse the gyroscopic effects and applications of gyroscope.
**ME2402.6** Demonstrate the need and various industrial employable techniques of balancing of Mechanical systems.

## B. 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.

**Programme Specific Outcomes**

**[PSO.1].** Model and analyse of Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## C. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 15 |
| | Sessional Exam II (Closed Book) | 15 |
| | 1. Assignment - 12marks<br>2. Quiz-1 - 6 Marks<br>3. Quiz -2 -6 Marks<br>4. Quiz 3 -6 Marks | 30 |
| End Term Exam (Summative) | End Term Exam (Open Notes) | 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

- Static forces in Machines: Conditions of static equilibrium of a member under action of two forces, three forces, four forces and forces and a couple, Analysis of slider crank mechanism and four bar mechanism, example of quick return mechanism, Virtual work .
- Dynamic force analysis: Inertia forces, D Alembert's Principle, Inertia forces of connecting rod, inertia forces in slider crank mechanism, four bar mechanism, dynamically equivalent system, forces in engines, turning moment

diagram of single cylinder engines, multi cylinder engines, mass and size of flywheel.

- Balancing of rotating masses in machinery, Balancing in same plane, balancing in different planes, balancing of reciprocating masses, Primary balancing and Secondary balancing of multi cylinder engines, inline engines, V-engines, and radial engines using direct and revers cranks concept.
- Governors, Centrifugal governors such as Porter, Proell, Hartnell, and Wilson Hartnell. Characteristics of governors, stability, Sensitiveness, isochronism, hunting, controlling force, effort and power of governors.
- Gyroscope: Principle of Gyroscopic couple, Effect of gyroscopic couple and centrifugal force on vehicle taking a turn, Stabilization of sea vessels, Condition for stability of a four wheeler and two wheelers.

## E. TEXT BOOKS


- S. S. Rattan, "Theory of machines" Tata McGraw Hill, 4th Edition, 2014.
- Amitabha Ghosh & Asok Kumar Mallik, "Theory of Mechanisms and Machines" East West Press, 3rd Edition, 2006


## F. REFERENCE BOOKS


- Hamilton H. Mabie and Charles, "Mechanisms and dynamics of machinery" John Wiley and sons, 4th Edition1987.
- J.E.Shigley and Jr.Uicker, "Theory of Machines and Mechanisms" Oxford University press, 4th Edition, 2011.
- R L Norton, "Kinematics and Dynamics of Machinery" Tata McGraw-Hill Education, 1st Edition in SI unit, 2009.

**Lecture Plan:**

| Lec No | **Topics** | **Session Outcome** | **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 | NA |
| 2 | Introduction to dynamics and basic concepts of kinematics | Recall kinematics of various mechanism | Flipped Classroom | 2402.1 | In Class Quiz ( Not Accounted) |
| 3 | Two, three and four force member | Study equilibrium of forces on mechanism | Lecture | 2402.1 | In Class Quiz<br>End Term |
| 4,5 | Problems on static equilibrium | Practice of concept based numerical problems - I | Lecture | 2402.1 | Class Quiz<br>Mid Term I<br>End Term |
| 6 | Problems on static equilibrium | Practice of concept based numerical problems - II | Lecture | 2402.1 | Class Quiz<br>Mid Term I<br>End Term |
| 7 | D'Alembert's Principle and introduction to dynamic force analysis | Able to analyse various dynamic forces in mechanism | Lecture | 2402.1 | Class Quiz<br>Mid Term I<br>End Term |
| 8-10 | Dynamic analysis of slider crank mechanism<br>Angular velocity and acceleration of connecting rod<br>Force analysis of Engine | Able to calculate different forces on IC engine | Tutorial cum Lecture | 2402.2 | Class Quiz<br>Mid Term I<br>End term<br>Home Assignment |
| 11,12 | Problems on Engine force | Analyse the inertia and gas forces. | Tutorial cum Lecture | 2402.2 | Class Quiz<br>Mid Term I<br>End Term<br>Class Quiz<br>End Term |
| 13,14 | Dynamically equivalent system | Analyse the connecting rod inertia. | Lecture | 2402.2 | Class Quiz<br>Mid Term II<br>End Term |
| 15 | Correction Torque | Able to understand the effect of inertia of CR on moment of crank shaft | Lecture | 2402.2 | Class Quiz<br>Mid Term II<br>End Term |
| 16,17 | Problems on correction torque | Analyse the total torque and its effect on crank shaft | Lecture | 2402.2 | Class Quiz<br>Mid Term II<br>End Term<br>Class Quiz<br>Mid Term II<br>End Term |
| 18 | Turning moment diagram | Understanding of turning moment diagram | Lecture | 2402.3 | Class Quiz<br>End Term |
| 19 | Flywheel | Requirement of Flywheel | Flipped Class | 2402.3 | Class Quiz<br>End Term |
| 20,21 | Problems on flywheel and | Able to calculate | Tutorial cum | 2402.3 | Class Quiz<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| | TM Diagram | required inertia of flywheel for an engine | Lecture | | Class Quiz<br>End Term |
| 22 | Introduction to governor | Introducing | Lecture | 2402.4 | Class Quiz |

| | | | | | |
|---|---|---|---|---|---|
| | | Governors | | | End Term |
| 23 | Porter Governor and proell governor | Analyse the operation of governor | Flipped Class | 2402.4 | Class Quiz<br>End term |
| 24 | Spring loaded governors | Analyse the operation of governor | Flipped Class | 2402.4 | Class Quiz<br>Mid Term II<br>End Term |
| 25 | Spring loaded governors, Pickering Governor | Analyse the operation of governor | Flipped Class | 2402.4 | Class Quiz<br>Mid Term II<br>End Term |
| 26,27 | Problems on governors | Able to calculate different forces and speeds of different governor | Tutorial cum Lecture | 2402.4 | Class Quiz<br>Mid Term II<br>End Term |
| 28,29 | Sensitivity, Hunting, Isochronism and Stability and controlling force | Analyse and control the operation of governor | Lecture | 2402.4 | Class Quiz<br>End Term |
| 30 | Gyroscope couple | Introducing Gyroscopic effect | Lecture | 2402.5 | Class Quiz<br>End Term |
| 31 | Gyroscopic Effect on airplane and ship | Able to find the gyroscopic moment | Lecture | 2402.5 | Class Quiz<br>End Term |
| 32 | Gyroscopic effect on an automobile | Analyse the stability of vehicle | Lecture | 2402.5 | Class Quiz<br>End Term |
| 33 | Problems on above topic | Able to calculate different forces and reactions on vehicles | Tutorial cum Lecture | 2402.5 | Class Quiz<br>End Term |
| 34 | Static balancing | Introduction to Balancing | Lecture | 2402.6 | Class Quiz<br>End Term |
| 35 | Balancing of several masses on different planes | Analyse different procedure of balancing | Lecture | 2402.6 | Class Quiz<br>End Term |
| 36,37 | Problems on balancing different planes | Able to calculate the balancing mass | Lecture | 2402.6 | Class Quiz<br>End Term |
| 37,38 | Balancing of reciprocating engine | Analyse the unbalance force and couple | Lecture | 2402.6 | Class Quiz<br>End Term |
| 39 | Partial balancing | Able to minimize the unbalance force | Lecture | 2402.6 | Class Quiz<br>End Term |
| 40,41 | Multi-cylinder and V engine balancing | Able to balance the multi cylinder engines | Lecture | 2402.6 | Class Quiz<br>End Term |
| 42 | Problems | Able to calculate unbalance forces and balance them | Tutorial cum Lecture | 2402.6 | Class Quiz<br>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 |
| ME2402.1 | Identify the static and dynamics forces in different mechanism. | 3 | 1 | | | | | | | | | | 1 | | | |
| ME2402.2 | Estimate the forces and their effects on four bar mechanism (IC engines). | 3 | 2 | 2 | | 2 | | | | | | | 1 | 2 | | |
| ME2402.3 | Explain the computer based skill set to construct the turning moment diagram of crank shaft for different cycles and manipulate the diagram with the help of flywheel. | 3 | 2 | 2 | | 1 | | 1 | | | | | | 1 | | |
| ME2402.4 | Compare the operations of different types of governors and their applications. | 3 | 1 | 1 | | 1 | | 1 | | | | | | 1 | | |
| ME2402.5 | Analyse the gyroscopic effects and applications of gyroscope. | 3 | 2 | 2 | | 1 | | 2 | | | | | | 1 | | |
| ME2402.6 | Demonstrate the need and various industrial employable techniques of balancing of Mechanical systems. | 3 | 2 | 3 | | 2 | | | | | | | | | | |

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

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering, The course covers various methods and types of castings, welding processes, sheet metal forming and plastics. In a production shop, a successful engineer must have a thorough understanding of the subject if he/she has to select and implement the right processes. To impart knowledge on selection of suitable manufacturing process for the typical component. The selection of the important process parameter is extremely important to achieve the success in manufacturing. The knowledge of correct procedure, machine and parameter leads to the saving of material, rework and labour.

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

**[2403.1].** Apply different manufacturing processes in industries to increase chances of employability.
**[2403.2].** Recognize different casting processes for specific product.
**[2403.3].** Explain forming processes (forging, rolling and drawing).
**[2403.4].** Describe joining processes and their applications.
**[2403.5**]. Explain the concepts of processing of plastic.

**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.

**Programme Specific Outcomes:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I | 15 |
| | Sessional Exam II | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| 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/ HomeAssignment/ 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**

Casting: Introduction to casting, Patterns, types, materials, Allowances, Moulding sand composition, types of mould, Sand Testing Machine, Core types, Core making sands, Chills & Chaplets, Forces acting on Moulding flasks, Introduction to Crucible Melting & Cupola operation, Principles and design of Gating system, Gating Ratio, Riser types & Design, Concept of Solidification of casting, Introduction to Sand Casting, Special Casting Process Shell Mould Casting, Investment Casting, Die casting, Centrifugal Casting, CO2 Moulding, Applications-Advantages-Disadvantages of above processes, Defects in casting, causes & remedies. Metal Joining: Principles of welding, soldering, brazing. Types of welds and welded joints, Arc Welding its types Working, power sources, and electrodes and their coatings, weld bead geometry, V-I characteristic curves of power source, Simple Problems of V-I characteristic, Shielded Metal Arc Welding, Submerged Arc Welding, Gas Tungsten Arc Welding, Gas Metal Arc Welding, Gas Welding and Gas Cutting, Applications-Advantages-Disadvantages of above processes, Resistance Welding, Seam Welding, Projection Welding, Spot Welding, Heat Affected Zone in Welding, Minimization of HAZ, Special Welding Process – Friction Welding, Thermit Welding. Defects in Welding, causes & remedies. Metal Forming: Introduction to Metal Forming, Nature of plastic deformation, Hot and cold working, Strain hardening, Recrystallization and grain growth. Rolling: Principle, Types of rolling mills, Roll passes, Forces in rolling and power requirements. Extrusion: Basic extrusion process - Types. Forging: Principles of forging, Tools and dies, Types: Smith forging, Drop *Forging*, Forging hammers, Rotary forging, Forging defects, causes and remedies, Wire Drawing. Sheet Metal Forming: Spring back effect, Stamping, Blanking, Bending, Drawing, Piercing, Coining, Embossing, Stretch forming. Processing of Plastics: Types of Plastics,

Properties and applications, Processing Methods & Equipment (Blow & Injection Moulding)

**F. TEXT BOOKS**

1. S. Kalpakjian and S.R. Schmid, *Manufacturing Engineering and Technology*, Pearson Education, 6th Edition, 2009.
2. A. Ghosh, and A.K. Malik, *Manufacturing Science,* Affiliated East West Press Pvt. Ltd., 2nd Edition, 2010.

**G. REFERENCE BOOKS**

1. P.C. Sharma, *A text book of Production Technology*, S. Chand and Company, 4th Edition, 2006.
2. R.K. Jain, *Production Technology: Manufacturing Processes, Technology and Automation*", Khanna Publishers, 17th Edition, 2011.
3. P.N. Rao, *Manufacturing Technology Volume-1*, Tata McGraw-Hill Education, 4th Edition, 2013.

**H. LECTURE PLAN**

| Lecture | Topic | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| **L1** | Introduction and Course Hand-out briefing | To acquaint and clear teachers expectations and understand student expectations | Lecture | NA | NA |
| **L2** | Introduction & classification of manufacturing processes | Student will able to differentiate different manufacturing processes. | Lecture/PPT | ME2403.1 | Quiz<br>Mid term I<br>Assignment |
| **L3** | Introduction of casting, Types of patterns. | Distinguish between patterns | Lecture/PPT | ME2403.2 | Quiz<br>Mid term I |
| **L4** | Pattern allowances. Types of mould. | Identify moulds and apply pattern allowances in pattern making | Lecture/PPT | ME2403.2 | Quiz<br>End term<br>Assignment |
| **L5** | Sand & sand properties | Identify the sand and use it for making a mould. | Lecture/PPT | ME2403.2 | Quiz<br>Mid term I |
| **L6** | Melting furnaces | Recognize furnaces | Lecture/PPT | ME2403.2 | Quiz<br>Mid term I |
| **L7** | Gating design, Cooling & solidification | Describe the gating system design and handling of molten material. | Lecture/PPT | ME2403.2 | Quiz<br>Assignment<br>End term |
| **L8** | Casting processes: Die casting | Able to explain to explain die casting process | Lecture/PPT | ME2403.2 | Quiz<br>Mid term I |

| | | | | | |
|---|---|---|---|---|---|
| **L9** | Shell moulding & investment casting | Explain and implement about shell and investment casting | Lecture/PPT | ME2403.2 | Quiz<br>End term |
| **L10** | Centrifugal casting, slush casting & CO2 casting | Identify the product making from these processes. | Lecture/PPT | ME2403.2 | Quiz<br>Mid term I |
| **L11** | Defects in casting & inspection techniques | Recall about the various defects and they can find possible solution for the same. | Lecture/PPT | ME2403.2 | Quiz<br>End term<br>Assignment |
| **L12** | Introduction of forming process | Distinguish between casting and forming process | Lecture/PPT | ME2403.1 | Quiz |
| **L13** | Plastic deformation and yield criteria | Recall various deformation processes | Lecture/PPT | ME2403.3 | Quiz<br>Mid term I |
| **L14** | Relation between tensile and shear yield stresses | Understand mechanical properties of plastic | Lecture/PPT | ME2403.3 | Quiz |
| **L15** | Hot working & cold working | Examine the various forming based on recrystallization temperature | Lecture/PPT | ME2403.3 | Quiz<br>Assignment |
| **L16** | Introduction of rolling & rolling principle | Recall various aspects of the rolling process | Lecture/PPT | ME2403.3 | Quiz<br>Mid term I |
| **L17** | Rolling stand arrangement | Design a rolling process using advanced software | Lecture/PPT | ME2403.3 | Quiz |
| **L18** | Rolling load, roll passes, Rolling defects | Recall rolling process and examine its defects | Lecture/PPT | ME2403.3 | Quiz<br>End term |
| **L19** | Introduction to forging | Learn about forging process and its importance. | Lecture/PPT | ME2403.1 | Quiz<br>Mid term I |
| **L20** | Upsetting, smith forging, drop forging | Able to solve problems in upsetting and smith forging and design the same for specific product | Lecture/PPT | ME2403.3 | Quiz<br>Mid term I |

| | | | | | |
|---|---|---|---|---|---|
| **L21** | Fullering,edging, blocking, trimming | Recall the various processes and design the same for specific product | Lecture/PPT | ME2403.3 | Quiz<br>End term |
| **L22** | Press forging | Recognize press forging | Lecture/PPT | ME2403.3 | Quiz<br>Assignment |
| **L23** | Machine forging, Forging defects | Able to solve problems in forging and defects. | Lecture/PPT | ME2403.3 | Quiz<br>End term |
| **L24** | Introduction of extrusion & extrusion principle | Recall various metal reduction processes related to the primary manufacturing processes. | Lecture/PPT | ME2403.3 | Quiz<br>Mid term I |
| **L25** | Forward, backward, impact extrusion | Learn about various applications of and its usage | Lecture/PPT | ME2403.3 | Quiz<br>End term |
| **L26** | Wire drawing, Rod & tube drawing | Learn about importance of various forging process and possible area of application. | Lecture/PPT | ME2403.3 | Quiz<br>Mid term II |
| **L27** | Sheet metal operations, blanking, punching | Recall importance of process and possible area of application. | Lecture/PPT | ME2403.5 | Quiz<br>Assignment |
| **L28** | Drawing, spinning, bending, embossing & coining | Distinguish about different sheet metal process and application of processes. | Lecture/PPT | ME2403.5 | Quiz<br>Mid tem II |
| **L29** | Sheet metal die design | Learn the factors used in sheet metal working and designing of sheet metal die. | Lecture/PPT | ME2403.5 | Quiz<br>Assignment<br>End term |
| **L30** | Introduction of welding, types of joints | Distinguish among the welding processes | Lecture/PPT | ME2403.1 | Quiz |
| **L31** | Gas welding, oxy acetylene welding equipment | Describe various factors of gas welding and their parameters | Lecture/PPT | ME2403.4 | Quiz<br>End term |

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|---|---|---|---|---|---|
| **L32** | oxy acetylene welding techniques & gas cutting | Design their own gas welding process | Lecture/PPT | ME2403.4 | Quiz<br>Mid tem II |
| **L33** | Principle of arc welding & arc welding Equipments | Employ the different arc welding for a specific product | Lecture/PPT | ME2403.4 | Quiz<br>Assignment |
| **L34** | Electrodes, manual arc welding, carbon arc welding | Recall the various electrode and their importance in welding | Lecture/PPT | ME2403.4 | Quiz |
| **L35** | Inert gas shielding arc welding, GTAW | Employ the different arc welding for a specific product | Lecture/PPT | ME2403.4 | Quiz<br>End term |
| **L36** | GMAW, Submerge arc welding | Employ the different arc welding for a specific product | Lecture/PPT | ME2403.4 | Quiz<br>Assignment |
| **L37** | Principle of resistance welding, resistance welding Equipments | Describe the different types of pressure welding and its importance | Lecture/PPT | ME2403.4 | Quiz<br>Mid term II |
| **L38** | Spot welding, seam welding, projection welding | Recall the different types of pressure welding and its applications | Lecture/PPT | ME2403.4 | Quiz<br>End term II |
| **L39** | Upset welding, flash welding | Recognize the different types of pressure welding | Lecture/PPT | ME2403.4 | Quiz |

| | | | | | |
|---|---|---|---|---|---|
| **L40** | Thermit welding, Electro slag welding | Describe the thermit & electro slag welding and its application | Lecture/PPT | ME2403.4 | Quiz<br>End term |
| **L41** | Electron beam welding, laser beam welding | Employ the different types of different welding | Lecture/PPT | ME2403.4 | Quiz<br>Mid term II |
| **L42** | Forge welding, friction welding, diffusion welding | Distinguish about various solid state welding processes and its application | Lecture/PPT | ME2403.4 | Quiz<br>Mid term II |
| **L43** | Brazing & soldering | Employ the different types of brazing and soldering | Lecture/PPT | ME2403.4 | Quiz<br>Mid term II |
| **L44** | Properties of plastic, Additives in plastics | Learn about different constituent of materials and additive materials other than parent material used in plastic industry. | Lecture/PPT | ME2403.5 | Quiz<br>Assignment |
| **L45** | plastic materials, Extrusion of plastics | Acquire about various types of plastics materials used for plastics and different process of making product. | Lecture/PPT | ME2403.5 | Quiz<br>End term |
| **L46** | Injection moulding | Recall the importance of injection moulding and possible area of application. | Lecture/PPT | ME2403.5 | Quiz<br>Assignment |

| | | | | | |
|---|---|---|---|---|---|
| **L47** | Blow moulding, Thermoforming | Learn about importance of blow moulding and thermoforming and its applications. | Lecture/PPT | ME2403.5 | Quiz<br>End term |
| **L48** | Conclusion and Course Summarization | NA | NA | NA | NA |

**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 |
| ME2403.1 | Apply different manufacturing processes in industries to increase chances of employability. | 3 | | | | | | | | | | | | | | |
| ME2403.2 | Recognize different casting processes for specific product. | 3 | | 2 | | | | | | | | | | | | 2 |
| ME2403.3 | Explain forming processes (forging, rolling and drawing). | 3 | | 2 | | | | | | | | | | | | 2 |
| ME2403.4 | Describe joining processes and their applications. | 3 | | | | | | | | | | | | | | 2 |
| ME2403.5 | Explain the concepts of processing of plastic. | 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

Production Technology I Lab | ME 2431 | 1 Credits | 0 0 1 0

Session: 2020-21| Faculty: Anurag Joshi / SS Sharma | Class: Regular

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering, The course covers concepts of Forming Technology, Casting and Welding Processes. A practical exposure is provided to the learners of this course by hands on practices of various practical sessions.

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

[ME2431.1] Acquire skills related to casting and forging

[ME2431.2] Identify different types of sand casting tools and procedures

[ME2431.3] Describe the various welding tools and processes

[ME2431.4] Identify different smithy tools and processes

[ME2431.5] Analyse various process parameters of forming processes

## 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.

## Programme Specific Outcomes:

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Viva | 15 |
| | Record | 15 |
| | Performance | 30 |
| 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**

Introduction: smithy and foundry; Practical study on smithy process: preparation of models; Practical Study on moulding process: by preparation of models; Practical study on non- ferrous: metal casting.

Welding Practice: Preparation of welding joints by gas welding and arc welding.

**F. TEXT BOOKS**

1. S.K. Chaudhury and S.K. Hajara, Elements of Workshop Technology Vol.1, Media Promoters & Publishers Pvt. Ltd., 14th Edition, 2010.

2. B.S. Raghuvanshi, A course in Workshop Technology Vol.1, Dhanpat Rai & Sons.Delhi, 4th Edition, 2014.

## G. LECTURE PLAN

| Sl. No. | Name of the experiment | Session Outcome | CO | Mode of Delivery | Evaluation |
|---|---|---|---|---|---|
| 1 | Study foundry tools, casting process, types of patterns and casting sand | Hands on experience | ME2431.1, ME2431.2, ME2431.5 | Practical & Demonstration | Performance/Viva/Record |
| 2 | Green sand mould preparation for single piece pattern | Hands on experience | ME2431.1, ME2431.2, ME2431.5 | Practical & Demonstration | Performance/Viva/Record |
| 3 | Perform casting of T- shaped joint with aluminium molten metal | Hands on experience | ME2431.1, ME2431.2, ME2431.5 | Practical & Demonstration | Performance/Viva/Record |
| 4 | Prepare green sand mould for split pattern | Hands on experience | ME2431.1, ME2431.2, ME2431.5 | Practical & Demonstration | Performance/Viva/Record |
| 5 | Perform casting of split pattern with aluminium molten metal | Hands on experience | ME2431.1, ME2431.2, ME2431.5 | Practical & Demonstration | Performance/Viva/Record |
| 6 | Study smithy shop, different tools and operations | Hands on experience | ME2431.1, ME2431.4, ME2431.5 | Practical & Demonstration | Performance/Viva/Record |
| 7 | Perform smithy operation by making chisel | Hands on experience | ME2431.1, ME2431.4, ME2431.5 | Practical & Demonstration | Performance/Viva/Record |
| 8 | To make an S - hook from a given round bar, by following hand forging operation | Hands on experience | ME2431.4 | Practical & Demonstration | Performance/Viva/Record |
| 9 | Study different types of welding processes | Hands on experience | ME2431.3 | Practical & Demonstration | Performance/Viva/Record |
| 10 | To join two given metal plates by a square butt joint in arc welding | Hands on experience | ME2431.3 | Practical & Demonstration | Performance/Viva/Record |
| 11 | To join two given metal plates by a Lap joint in arc welding | Hands on experience | ME2431.3 | Practical & Demonstration | Performance/Viva/Record |
| 12 | To join two given metal plates by a square butt joint in gas welding | Hands on experience | ME2431.3 | Practical & Demonstration | Performance/Viva/Record |
| 13 | To join two given metal plates by a Lap joint in Gas Welding | Hands on experience | ME2431.3 | Practical & Demonstration | Performance/Viva/Record |
| 14 | Study and demonstration of heat treatment process | Hands on experience | ME2431.5 | Practical & Demonstration | Performance/Viva/Record |

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

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOM | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 |
| [ME2431.1] | Acquire skills related to casting and forging | 3 | | 1 | | 1 | | | |
| [ME2431.2] | Identify different types of sand casting tools and procedures | 3 | | | 1 | | | | |
| [ME2431.3] | Describe the various welding tools and processes | 3 | 1 | 2 | | | | | |
| [ME2431.4] | Identify different smithy tools and processes | 3 | | 1 | | | | | |
| [ME2431.5] | Analyse various process parameters of forming processes | 3 | | 1 | | | | | |

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

**A. Course Introduction:** Today's world consists of many local, national, multinational and global organizations. Success of all business depends on their effective and efficient management. Therefore, management plays a most powerful and crucial role in the success and survival of the whole world. The significance of the course enlightens the dynamic life-giving element in every business. Consequently, it will emerge as a great resource as well an important 'discipline of learning' in the modern business world. The objective is to provide an understanding of basic concepts, principles and practices of organisation and management. The aim is to inculcate the ability to apply multifunctional approach to organizational objectives. This course will enable students understand the basic concept of organization and management and various functions of it.

**B. Course Outcomes:** On completion of the course the students shall be able to:

**[BB1540.1].** Understand theory and practice of organization and management.
**[BB1540.2].** Build a comprehensive knowledge about marketing and personnel management
**[BB1540.3].** Develop the skills of leadership and motivation.
**[BB1540.4].** Illustrate the concept of entrepreneurship to inculcate the employability skills.
**[BB1540.5].** Develop the knowledge of management information system (MIS).

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

**[PO.1]. Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives**.**

**[PO.2]. Effective Communication:** Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

**[PO.3]. Social Interaction**: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

**[PO.4]. Effective Citizenship:** Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

**[PO.5]. Ethics:** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

**[PO.6]. Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.

**[PO.7]. Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

**[PSO.1]. Understanding Traditional and Contemporary Managerial Concepts and Models**: Understanding in detail, the contents of various functional areas of Business & Management and the implications of psychological and behavioral aspects on the organizations.

**[PSO.2]. Analyzing Business Environment:** Identifying opportunities existing in the domestic and global business and economic environment and initiating systematic approach towards rational decision making.

**[PSO.3]. Application of Business Concepts and Managerial Skills:** Implementing conceptual knowledge in real business situations for ensuring business sustainability and growth.

## 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) | 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

**Unit 1:** Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising.

**Unit 2:** Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower.

**Unit 3:** Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, and Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories.

**Unit 4:** Entrepreneurship – Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit.

**Unit 5:** Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

## F. Text Books

T1. Koontz, Harold, Cyril O'Donnell, and Heinz Weihrich: Essentials of Management, Tata McGraw-Hill, New Delhi
T2. Robbins, Stephen P, and Mary Coulter: Management, Prentice Hall, New Delhi T3. E. S. Buffa and R. K. Sarin "Modern Production / Operations Management", 8th Edition, Wiley, 1987

## G. Reference Books

R1. H. J. Arnold and D. C. Feldman "Organizational Behavior", McGraw – Hill
R2. Aswathappa K: Human Resource and Personnnel Management, Tata McGraw Hill
R3. William Wether& Keith Davis, Human Resource and Personnel Management, McGraw Hill

## H. Lecture Plan

| Lecture No. | PARTICULARS | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1. | Meaning and definition of an organization, Necessity of Organization | Understands the importance and concepts of organization management. | Lecture PPT , Discussion | BB1540.1 | Class Quiz Mid Term I End Term |
| 2. | Principles of Organization, Formal and Informal Organizations | Learn and understand the process and principles as well learn types of organizations | Lecture PPT, Discussion | BB1540.1 | Class Quiz Mid Term I End Term |
| 3. | Management Function: Planning & Organizing | Learn the principles of management and administration as well how they are applicable in a business Organization | Lecture PPT, Discussion | BB1540.1 | Class Quiz Mid Term I End Term |
| 4. | Management Function: Leading & Controlling | Understand the basic process of various management functions and how they are applicable in the organization | Lecture PPT, Discussion | BB1540.1 | Class Quiz Mid Term I End Term |
| 5. | Managerial Skills, Importance of Management, | Understanding of different managerial skills | Lecture PPT, Discussion | BB1540.1 | Class Quiz Mid Term I End Term |
| 6. | Activity | Understanding of previous lectures | Class activity | BB1540.1 | Quiz/ Case study |
| 7. | Models of Management: Scientific and Administrative management | Students will gain the knowledge of different Scientific and Administrative management | Lecture , Discussion | BB1540.1 | Class Quiz Mid Term I End Term |
| 8. | Models of Management: Behavioral approach | Understand the approach of behavioral management | Lecture , Discussion | BB1540.1 | Class Quiz Mid Term I End Term |

| | | | | | |
|---|---|---|---|---|---|
| 9. | Activity related models of management | Understanding of previous lectures | Class activity | BB1540.1 | Class Quiz/ case study |
| 10. | Forms of Ownership and Organization Structures | Understanding of Ownership and Organization Structures | Lecture, Discussion | BB1540.2 | Class Quiz<br>Mid Term I<br>End Term |
| 11. | Activity | Understanding of previous lectures | Class activity | BB1540.2 | Class Quiz/ case study |
| 12. | Purchasing Function and Marketing Function | Understanding of purchasing function and marketing function | Lecture PPT ,Discussio n | BB1540.2 | Class Quiz<br>Mid Term I<br>End Term |
| 13. | Advertising and Changing Dynamics of Advertising | Students will gain knowledge of advertising and how advertising is changing with market | Lecture PPT, Discussion | BB1540.2 | Class Quiz<br>Mid Term I<br>End Term |
| 14. | Activity | Understanding of previous lectures | Class activity | BB1540.2 | Class Quiz/ case study |
| 15. | Introduction, Functions of Personnel Management, Development of Personnel Policy | Understanding of human resource function and policies of personnel management | Lecture PPT, Discussion | BB1540.2 | Class Quiz<br>Mid Term II<br>End Term |
| 16. | Manpower Planning | Students will gain the knowledge of manpower planning | Lecture, Discussion | BB1540.2 | Class Quiz<br>Mid Term II<br>End Term |
| 17. | Recruitment of Manpower | Students will gain the knowledge of various steps and process of recruitment in human resource | Lecture PPT, Discussion : | BB1540.2 | Class Quiz<br>Mid Term II<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 18. | Selection of Manpower | Students will gain the knowledge of various steps and process of selection in human resource | Lecture PPT, Discussion | BB1540.2 | Mid Term II End Term |
| 19. | Activity | Understanding of previous lectures | Class activity | BB1540.2 | Class Quiz/ case study |
| 20. | Introduction to Motivation, Human needs, Maslow's Hierarchy of needs | Understand the meaning of the motivation, human needs and the Maslow's theory of motivation Students will learn various types of motivation. | Recap of previous lecture, Lecture PPT, Discussion | BB1540.3 | Class Quiz Mid Term II End Term |
| 21. | Types and techniques of Motivation | Understand different techniques of motivation and their uses. | Lecture PPT, Discussion | BB1540.3 | Class Quiz Mid Term II End Term |
| 22. | McGregor's Theory, Herzberg's Hygiene Maintenance Theory | Students will learn the popular theories of motivation. | Lecture PPT, Discussion | BB1540.3 | Class Quiz Mid Term II End Term |
| 23. | Activity | Understanding of previous lectures | Class activity | BB1540.3 | Class Quiz/ case study |
| 24. | Leadership - Introduction Qualities of a good Leader, Leadership Styles | Students will learn different approaches of leadership. | Lecture PPT, Discussion | BB1540.3 | Class Quiz Mid Term II End Term |
| 25. | Leadership Theories | Understand different theories of leadership | Lecture PPT, Discussion | BB1540.3 | Class Quiz Mid Term II End Term |
| 26. | Leadership Theories | Understand different theories of leadership | Class Activity, PPT | BB1540.3 | Class Quiz Mid Term II End Term |

| | | | | | |
|---|---|---|---|---|---|
| 27. | Activity | Understanding of previous lectures | Class activity | BB1540.3 | Class Quiz/ case study |
| 28. | Entrepreneurship – Introduction, Entrepreneurship Development | Students will learn about entrepreneurship and its development. | Lecture PPT, Discussion | BB1540.4 | Class Quiz Mid Term II End Term |
| 29. | Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship | Understand the characteristics and need for promoting entrepreneurship unit. | Lecture, Discussion | BB1540.4 | Class Quiz Mid Term II End Term |
| 30. | Steps for establishing small scale unit | Analyze the various steps involved in establishing small scale. | Lecture PPT, Discussion | BB1540.4 | Class Quiz Mid Term II End Term |
| 31. | Activity | Understanding of previous lectures | Class activity | BB1540.4 | Class Quiz/ case study |
| 32. | Data and Information; Need and Importance of MIS | Understand the difference between data and information and the importance of managerial information system in an organization. | Lecture, Discussion | BB1540.5 | Class Quiz End Term |
| 33. | Functions of MIS and Evolution of MIS | Understand different phases related to evolution of MIS. | Lecture PPT, Discussion | BB1540.5 | Class Quiz End Term |
| 34. | Activity | Understanding of previous lectures | Class activity | BB1540.5 | Class Quiz/ case study |
| 35. | Organizational Structure and MIS | Understand the use of managerial information system in organizational structure. Student will learn about management information system. | Lecture PPT, Discussion | BB1540.5 | Class Quiz End Term |

| | | | | | |
|---|---|---|---|---|---|
| 36. | Activity | Analyze the close ended case study related to the management. | Case study | BB1540.5 | Case study analysis |
| 37. | Computers and MIS | Understand the basic requirement of management and computers in business | Lecture PPT, Discussion | BB1540.5 | Class Quiz End Term |
| 38. | Classification of Information Systems and Information Support for functional areas of management | Learn the importance of Control and it is the fourth and final principle element of the managerial process. | Lecture PPT, Discussion | BB1540.5 | Class Quiz End Term |
| 39. | Classification of Information Systems and Information Support for functional areas of management | Lear the controlling that intends toensure that everything occurs in conformity with the plans | Lecture PPT, Discussion | BB1540.5 | Class 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 | PSO 1 | PSO 2 | PSO 3 |
| **BB 1540.1** | Understand theory and practice of organization and management | 2 | | | | | | | 2 | | 2 |
| **BB 1540.2** | Build a comprehensive knowledge about marketing and personnel management | | 1 | 2 | | | | | | 1 | |
| **BB 1540.3** | Develop the skills of leadership and motivation. | | 2 | 2 | | 2 | | | 2 | | |
| **BB 1540.4** | Illustrate the concept of entrepreneurship. | 2 | | | 1 | | 1 | | 1 | | |
| **BB 1540.5** | Develop the knowledge of management information system. | | | | | | | | | | 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

Design of Machine elements-I |ME 1506 | 4 Credits | 3 1 0 4

Session: July 20 – Dec 20 | Faculty: Prof Sasanka Sekhar Ghosh/ Mr. Rakesh Kumar/ Dr. Ashish Kumar Srivastava

**A. INTRODUCTION:** This course is offered by Dept. of Mechanical Engineering, targeting students who wish to pursue design, research & development in industries or higher studies in field of Mechanical Engineering, including basics of machine design including the design process, engineering mechanics and materials, failure prevention under static and variable loading. Offers in depth knowledge of practical approach through a wide range of applications and examples of design and analysis. Subject provide the knowledge to analyse the type of loads that are responsible for the failure of parts and prediction of the failure of the parts based on different theories of failure.

**B. COURSE OUTCOMES:** At the end of the course, students will be able to

**[ME 1506.1].** Understand the design process, material selection, identify stresses for in machine components
**[ME 1506.2].** Evaluate the dimensions of the machine elements which are subjected to static loading.
**[ME 1506.3].** Analyse the machine elements subjected to fluctuating loads.
**[ME 1506.4].** Analyse shafts, keys and couplings.
**[ME 1506.5].** Undertand the design process of riveted, welded joints, threaded fastener subjected to different loading conditions.
**[ME 1506.6].** Design of power screws for various applications to increase his/her 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, 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.

**Programme Specific Outcomes**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. ASSESSMENT PLAN:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open 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

Machine Design philosophy. **Engineering Materials**: Stress-strain diagrams for ductile and brittle materials, **Stresses in Machine Elements**: Types of simple stresses, State of stress at point-implications, principal stresses and compound stresses. **Design for strength**: Static loading, Theories of failures, Allowable stress, Factor of safety, Stress concentration factor, curved beams. Variable and impact loading. **Shafts** - ASME & ISI code equations for design of transmission shafts, design of shafts subjected to combined load. **Key and couplings design**. **Riveted joints:** Structural joints of lap & butt types, Boiler joints, Rivets Coursed to eccentric loading conditions. **Welded joints**: Types of welding joints and symbols, Strength of welded joints and Design principle. Eccentric loading in welded joint Threaded fasteners, **Power screws**

## F. TEXT BOOK:

1. J.E. Shigley and C.R. Mischke, *Mechanical Engineering Design*, McGraw Hill Publication, 7th Edition, 2003.
2. V. B. Bhandari, Design of Machine Element, McGraw Hill Education Pvt. Ltd., 4th Edition, 2017.

## G. REFERENCE BOOKS:

1. R. L. Norton, *Machine Design-An Integrated Approach*, Pearson Publisher, 5th Edition, 2013.
2. U.C. Jindal, *Machine Design*, Pearson publisher, 1st Edition, 2010.
3. V. B. Bhandari, *Machine Design Data book*, McGraw Hill Publication, 2014.

## H. LECTURE PLAN:

| Lecture S.no. | Portions to be covered | Mode of delivery | Corresponding CO | Mode of assessing the outcome |
|---|---|---|---|---|
| L1 | **Introduction** to machine design | Lecture, PPT | ME 1506.1 | Short question |
| L2 | Materials and their properties, Material Specification | Lecture, C&T, PPT | ME 1506.1 | Quiz. Mid term I |
| L3 | Stress-Strain diagrams, Strain Energy, Resilience, Toughness, Hardness | Lecture, C&T | ME 1506.1 | Quiz |
| L4 | Creep & Temperature, contact stresses, | Flipped Classroom | ME 1506.1 | Class Quiz |
| L5 | **Concept of normal and shear stress** | Self study, Activity | ME 1506.1 | Quiz, Short question |
| L6 | Concept of bending and torsional shear stress, combined stress | Flipped Classroom | ME 1506.1 | Quiz, Short question |
| L7 | **Design based on static load**: Strength Concepts: Principle Stresses, Theories of failure, Factor of Safety | Lecture, C&T | ME 1506.2 | Class Quiz, Mid term I |
| T1 | Numerical problems | Tutorial practice | ME 1506.2 | Mid term I |
| L8 | Design and analysis of stresses of curve beam | Lecture, C&T | ME 1506.2 | Class Quiz, Home assignment 1 |
| L9 | Numerical problems | Lecture, C&T | ME 1506.2 | Class Quiz, Mid term I |
| L10 | Design of machine part subjected to static load | Tutorials | ME 1506.2 | Mid term I |
| L11 | **Fluctuating stresses:** Stress concentration factor, fluctuating stresses, endurance limit, notch sensitivity, S-N diagram | Lecture, C&T | ME 1506.3 | Class Quiz |
| L12 | Reverse stresses-design for finite and infinite life | Lecture, C&T | ME 1506.3 | Class Quiz, Mid term I |

| | | | | |
|---|---|---|---|---|
| L13 | Numerical problems | Lecture, C&T | ME 1506.3 | Class Quiz, Home assignment 2 |
| L14 | Goodman & Soderberg diagram, | Lecture, C&T | ME 1506.3 | Class Quiz, Mid term I |
| L15 | Modified Goodman diagram | Lecture, C&T | ME 1506.3 | Mid term I, End term |
| L16 | Stresses due to combined loading | Lecture, C&T | ME 1506.3 | Home assignment 3, End term |
| L17 | Numerical problems | Tutorials | ME 1506.3 | Mid term I |
| L18 | Summary | Activity, C&T | ME 1506.3 | Activity assessment |
| L19 | **Shafts**: Torsion of circular solid & hollow shafts | Lecture, C&T | ME 1506.4 | Class quiz |
| L20 | Design of shafts subjected to bending in two planes in addition to axial loads | Lecture, C&T | ME 1506.4 | Class quiz |
| L21 | Design of shafts according to ASME code | Lecture, C&T | ME 1506.4 | Home assignment 4 |
| L22 | Numerical problems | Lecture, C&T | ME 1506.4 | Class quiz, Mid term-II |
| L23 | -DO- | Lecture, C&T | ME 1506.4 | Quiz, End term |
| L24 | Types of Keys , Stresses in Keys | PPT | ME 1506.4 | Class quiz |
| L25 | Design of square Keys, Numerical problems | Lecture, C&T | ME 1506.4 | Mid term-II |
| L26 | Types of coupling | PPT | ME 1506.4 | Class quiz |
| L27 | Design of rigid coupling | Lecture, C&T | ME 1506.4 | Quiz |
| L28 | Numerical problems | Lecture, C&T | ME 1506.4 | Short question |
| L29 | Design of flexible coupling | Lecture, C&T | ME 1506.4 | Home assignment 5 |
| L30 | Numerical problems | Lecture, C&T | ME 1506.4 | Class quiz |
| L31 | **Riveted joints**: types of joints | Lecture, PPT | ME 1506.5 | Class quiz |
| L32 | Strength and efficiency of Riveted joints, Numerical problems | Lecture, C&T | ME 1506.5 | Class quiz, Mid term-II |
| L33 | Riveted joints for boiler, Numerical problems | Lecture, PPT, C&T | ME 1506.5 | Class quiz, Mid term-II |
| L34 | Riveted joints for eccentric loading, Numerical problems | Tutorials | ME 1506.5 | Observations, End term |
| L35 | -DO- | Flipped Classroom | ME 1506.5 | Class quiz |
| L36 | **Welded Joints:** types of welds, welding symbol | Lecture, PPT | ME 1506.5 | Class Quiz |
| L37 | Strength of weld joint, design principle | Lecture, C&T | ME 1506.5 | Class quiz |
| L38 | Numerical problems | Lecture, C&T | ME 1506.5 | End term |
| L39 | Design for welded joints subjected to eccentric loading | Lecture, C&T | ME 1506.5 | Class quiz, Home assignment 6 |
| L40 | Numerical problems | Lecture, C&T | ME 1506.5 | End term |
| L41 | Summary | Activity | ME 1506.5 | Activity assessment |
| L42 | **Threaded Fasteners :** Stresses in bolts | Lecture, PPT, C&T | ME 1506.5 | Class quiz |
| L43 | Effect of initial tension | Lecture, C&T | ME 1506.5 | End term |
| L44 | Dynamic and impact loading on bolts | Lecture, C&T | ME 1506.5 | End term |
| L45 | Numerical problems | Flipped Classroom | ME 1506.5 | Class quiz, End term |
| L46 | Bolts subjected to eccentric loading | Lecture, C&T | ME 1506.5 | Class quiz |
| L47 | Numerical problems | Tutorials | ME 1506.5 | End term |
| L48 | Summary | Activity | ME 1506.5 | Activity assessment |
| L49 | **Power Screws:** Stresses in power screws | Lecture, PPT, C&T | ME 1506.6 | Class quiz |
| L50 | Efficiency of power screws | Lecture, C&T | ME 1506.6 | Class quiz |
| L51 | Force and torque requirement to lift load/lower in power screw jack | Lecture, C&T | ME 1506.6 | Class quiz |
| L52 | Numerical problems | Lecture, C&T | ME 1506.6 | Class quiz |

| | | | | |
|---|---|---|---|---|
| L53 | Design process of power screw | Lecture, C&T | ME 1506.6 | Class quiz |
| l54 | Application base problems | Lecture, C&T | ME 1506.6 | End term |
| L55 | -DO- | Flipped Classroom | ME 1506.6 | Quiz, End term |
| L56 | Summary | Activity | ME 1506.6 | Activity assessment |

## 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 |
| ME 1506.1 | Understand the design process, material selection, identify stresses for in machine components | 2 | 2 | 1 | | | 1 | | | | | | | | | |
| ME 1506.2 | Evaluate the dimensions of the machine elements which are subjected to static loading. | 2 | 2 | 2 | 2 | | | | | | | | 2 | | | |
| ME 1506.3 | Analyse the machine elements subjected to fluctuating loads. | 3 | 3 | 3 | 3 | | | | | | | | 2 | 2 | | |
| ME 1506.4 | Analyse shafts, keys and couplings | 3 | 3 | 3 | 3 | | | | | | | | 2 | 2 | | |
| ME 1506.5 | Understand the design process of riveted, welded joints, threaded fastener subjected to different loading conditions | 3 | 3 | 3 | 3 | | | | | | | | 2 | 2 | | |
| ME 1506.6 | Design of power Screws for various applications to increase his/her employability | 3 | 3 | 3 | 3 | | | | | | | | 2 | 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

Heat and mass transfer| ME 1507 | 4 Credits | 4 0 0 4

Session: July 20– Dec 20 | Faculty: Prof. G.L. Sharma, Mr. Ankur Srivastava, Mr. Alok Kumar Ansu

**A. Introduction:** This course offered by Dept. of Mechanical Engineering deals with the rate of transfer of thermal energy. It has broad application area ranging from biological systems to common household appliances, electronic devices etc. The course covers various modes of heat transfer with their description and to use this analysis in the various applications like heat exchanger, condenser, evaporator etc. The course also requires a basic knowledge of Engineering Thermodynamics, Calculus, Fluid Mechanics

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

**ME1507.1** Understand basics of heat transfer: conduction, convection and radiation
**ME1507.2** Using skills apply principles of heat transfer to engineering systems.
**ME1507.3** Design and analyze the performance of heat exchanging devices.
**ME1507.4** Analyse the performance of phase change devices like evaporator and condenser.
**ME1507.5** To develop difference between heat and mass transfer on the basis of the driving potential governing them.

## 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.

**Programme Specific Outcomes**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 15 |
| | Sessional Exam II (Closed Book) | 15 |
| | Class Quizzes and Assignments | 20+10 |
| 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) | A 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

Introduction, Various modes of heat transfer. Conduction, Fourier law of heat conduction, Heat diffusion equation in Cartesian, Cylindrical and Spherical coordinate system, One dimensional steady state conduction applied to various cases e. g. plane wall, cylinder, sphere etc. Heat transfer from extended surfaces, Critical radius of insulation for cylinder & sphere, overall heat transfer coefficient, Convection, Review of Concept to Boundary Layer, empirical correlation for free & forced convection. Concept of Boiling and Evaporation, Boiling modes, Condensation: physical mechanism, Film and Dropwise condensation. Heat Exchanger, Heat Exchanger Analysis by LMTD and Effectiveness-NTU method. Radiation: - Radiation Intensity, Absorption,

Reflection and Transmission by real surfaces, Kirchhoff's Law, Gray surface. Radiation exchange between surfaces, Gray surfaces in an enclosure. Mass transfer: Introduction, diffusion mass transfer, Fick's law of diffusion, steady state molecular diffusion.

## F. TEXT BOOKS

- J.P.Holman, *Heat Transfer*, McGraw Hill, New York, 1997.

## G. REFERENCE BOOKS

- P.F. Incopera, D.P. Dewitt, *Fundamentals of Heat and Mass Transfer*, John Wiley Publication(2014)
- A. Yunus , Cengel, *Heat Transfer- A Practical Approach, Mc Graw Hill Publication,* Latest Edition

## H. Lecture Plan:

LECTURE PLAN

| Lecture S.no. | Portions to be covered | Mode of delivery | Corresponding CO | **Mode of assessing the outcome** |
|---|---|---|---|---|
| 1 | Introduction | Lecture | ME1507.1 | Class test+ Sessional I+ Assignment+ End Sem |
| 2 | Thermodynamics and heat transfer, basic modes of heat transfer and laws governing them | Lecture | ME1507.1 | |
| 3 | **Conduction:** Conduction Heat Transfer: Fourier Law of heat conduction, Conduction through a plane wall and composite rectangular wall (One dimensional steady state conduction) | Lecture | ME1507.1 | |
| 4 | Conduction through a cylindrical wall, composite cylindrical wall, sphere | Lecture | ME1507.1 | |
| 5 | Generalized thermal resistance network | Lecture | ME1507.1 | |
| 6 | Numerical problems | Lecture/Tutorial | ME1507.1 | |
| 7 | Overall heat transfercoefficient, thermal contact resistance, thermal diffusivity | Lecture | ME1507.1 | |
| 8 | General heat conduction equation in Cartesian, spherical and cylindrical coordinates | Lecture | ME1507.1 | |
| 9 | Numerical problems | Lecture/ Tutorial | ME1507.1 | |
| 10 | Critical radius of insulation for cylinder and sphere | Lecture | ME1507.2 | |
| 11 | Heat conduction with internal heat generation for a plane wall | Lecture | ME1507.1 | |
| 12 | Heat conduction with internal heat generation for a cylindrical wall | Flipped Classroom | ME1507.1 | |
| 13 | Numerical problems | Lecture/Tutorial | ME1507.1 | |
| 14 | Heat transfer from extended | Lecture | ME1507.2 | |

| | | | | |
|---|---|---|---|---|
| 21 | **Convection:** Basic concepts, Free and forced convection, Governing law, Viscous and inviscid flow | Lecture | ME1507.1 | Class Quiz+ Assignment+Sessional II+ End Term |
| 22 | Review of concepts to boundary layer, Laminar boundary layer on a flat plate | Lecture | ME1507.1 | |
| 23 | Hydrodynamic and Thermal boundary layer, Significance of dimensionless numbers | Lecture | ME1507.2 | |
| 24 | Drag and skin friction coefficient, Relation between fluid friction and heat transfer | Lecture | ME1507.2 | |
| 25 | Numerical Problems | Lecture/Tutorial | ME1507.2 | |
| 26 | Introduction to forced convection | Lecture | ME1507.2 | |
| 27 | Empirical correlations for forced convection- Pipe and Tube flow | Lecture | ME1507.2 | |
| 28 | Flow across cylinders and spheres | Flipped Classroom | ME1507.2 | |
| 29 | Numerical Problems | Lecture/Tutorial | ME1507.2 | |
| 30 | Free convection on a vertical flat plate, free convection for horizontal flat plate (Internal and external flow) | Lecture | ME1507.1 | |
| 31 | Free convection from horizontal cylinders | Lecture | ME1507.1 | |
| 32 | Numerical problems | Lecture | ME1507.2 | |
| 33 | Condensation and Boiling Heat Transfer: Introduction, Boiling and evaporation | Flipped Classroom | ME1507.4 | |
| 34 | Boiling modes and boiling heat transfer phenomenon, Simplified relations | Lecture/Tutorial | ME1507.4 | |
| 35 | Condensation mechanism, Film and drop wise condensation | Lecture | ME1507.4 | |
| 36 | Numerical problems | Lecture/Tutorial | ME1507.4 | |
| 37 | **Heat exchangers:** types and classifications | Lecture | ME1507.3 | |
| 38 | Analysis of heat exchangers, LMTD approach | Lecture | ME1507.3 | |
| 39 | Effectiveness and NTU approach, Fouling factor | Lecture | ME1507.3 | |
| 40 | Numerical Problems | Lecture/Tutorial | ME1507.4 | |
| SECOND SESSIONAL EXAM | | | | |
| 41 | **Radiation:** Salient features, absorptivity, Reflectivity and Transmissivity, radiation intensity | Lecture | ME1507.1 | |
| 42 | Intensity of emitted radiation, Emissive power, Black body and gray body radiation, | Lecture | ME1507.1 | |
| 43 | Kirchoffs law, Stefan Boltzmann law, Radiosity | Lecture | ME1507.1 | |
| 44 | Radiation exchange between surfaces | Lecture | ME1507.1 | |

| | | | | |
|---|---|---|---|---|
| 45 | Gray surfaces in an enclosure-Shape factor, reciprocity relation | Lecture/Tutorial | ME1507.1 | Class quiz + Assignment + End term |
| 46 | Mass Transfer**:** Introduction, Fick's law of diffusion, Molecular diffusion | Lecture | ME1507.5 | |
| 47 | Diffusion in solids, liquids and gases and mass transfer coefficient | Lecture | ME1507.5 | |
| 48 | Review | Lecture/Tutorial | ME1507.1-1507.5 | |
| 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 |
| ME1507.1 | Understand basics of heat transfer: conduction, convection and radiation | 3 | 2 | | | | 1 | 1 | | | | | 2 | | | |
| ME1507.2 | Apply principles of heat transfer to engineering systems | 3 | 1 | 1 | | | 1 | | | | | | 1 | | | |
| ME1507.3 | Design and analyze the performance of heat exchanging devices. | 3 | 2 | 1 | 1 | | | | | | | | | | | |
| ME1507.4 | Analyse the performance of phase change devices like evaporator and condenser. | 3 | 2 | 1 | 2 | | | | | | | | | 1 | | |
| ME1507.5 | Identify difference between heat and mass transfer on the basis of the driving potential governing them | 3 | 2 | 1 | | | | | | | | | 1 | | | |

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

**J. Course Outcome Attainment Level Matrix:**

**0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment**

# MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

Production Technology II | ME 1508 | 4 Credits | 4 0 0 4

Session: July 20 – Nov 20 | Faculty: Mr Anurag Joshi, Dr Mithilesh Kumar Dixit & Dr Ashok Kumar Sharma | Class: Regular

**A.** **Introduction:** This course is offered by Dept. of Mechanical Engineering, The course covers concepts of Machining, types of machines, calculations related to machining, economic aspects of machining, metal removal rate and theory of machining. In a production shop, a successful engineer must have a thorough understanding of the subject if he/she has to select and implement the right processes. The selection of the important process parameter is extremely important to achieve the success in manufacturing. The knowledge of correct procedure, machine and parameter leads to the saving of material, rework and labour. Further the subject is very important to deal with real time tool engineering problems.

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

I. Analyse Tool geometry and its attributes, Merchant circle diagram. Tool wear and Tool material.
II. Relate concepts of Machining of components of various sizes and shapes with the help of workshop machines in real time machining environment.
III. Recognize the Operations, Types and Use of Machines like Lathe, Milling, and Drilling etc.
IV. Calculate machining time and metal removal rate.

## 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.

## Programme Specific Outcomes:

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

### D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I | 15 |
| | Sessional Exam II | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| 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

Mechanics of Metal Cutting, Methods of Machining, Types of Cutting Tools, Cutting tool materials, cutting fluids, Nomenclature of Singlepoint cutting tool, Types of chips in machining process, Merchant's Theory, Tool wear and Tool life. Lathe: Introduction to Capstan and Turret lathe. Introduction to shaper, Planer & Slotter. Milling: Mechanics of Milling, Types of Milling Machines and Milling Cutters, Types of Milling processes, Concept of Indexing Mechanism/Dividing Head. Hole Making Operations: Mechanics of Drilling, Nomenclature of Twist Drill Bit, Types of Drilling Machines, Estimation of Machining time & Metal removal rate in Drilling operation. Finishing Operations: Mechanics of Grinding Operation, Specifications and Selection of Grinding Wheels. Lapping, Honing and Buffing, Broaching. Economics of metal machining.

### F. TEXT BOOKS

1. A. Ghosh, and A.K. Malik, *Manufacturing Science*, Affiliated East West Press Pvt. Ltd., 2nd Edition, 2010.
2. P.N. Rao, *Manufacturing Technology Volume-2*, McGraw Hill Publication, 4th Edition, 2013.
3. S. Kalpajian, and S.R. Schmid, *Manufacturing Engineering and Technology*, Pearson Publication, 4th Edition, 2002.

## G. REFERENCE BOOKS


1. P.C. Sharma, *A text book of production technology*, S. Chand Publication, 4th Edition, 2003.
2. R.K. Jain, *Production technology: Manufacturing Processes, Technology and MEtomation*, Khanna Publication, 17th Edition, 2011.


## H. LECTURE PLAN

| Lecture | Topic | Session Outcome | CO | Mode of Delivery | Evaluation |
|---|---|---|---|---|---|
| **L1** | Introduction of Machining, Variety of Machine Tools | Fundamentals of Machining process, Definition of machining and types of machine tools | NONE | Online PPT | MTE-1/END SEM |
| **L2** | Cutting Tools | Definition, Types, Different parts of single point cutting tool | I & II | Online PPT/video | MTE-1/END SEM |
| **L3** | Tool Signature or Tool Nomenclature | Orthogonal rake system (ORS), American Standards Association (ASA) | I | Online PPT/video | MTE-1/END SEM |
| **L4** | Tool Signature or Tool Nomenclature | Normal Rake System (NRS), Maximum Normal Rake System (MRS) | I | Online PPT/video | MTE-1/END SEM Quiz |
| **L5** | Mechanism of Chip Formation | Introduction, Types of Chips – Continuous chip without built up edge (BUE), Continuous chip with BUE and Discontinuous | I | Online PPT/video | MTE-1/END SEM Assignment Quiz |
| **L6** | Factors Affecting Chip Formation and Heat Generation | Depth of cut, feed, cutting velocity | I & II | Online PPT/video | MTE-1/END SEM |
| **L5** | Cutting Forces in Metal Cutting (Turning) | Force system in turning process, types of forces | I | Online PPT/video | MTE-1/END SEM |
| **L6** | Orthogonal Cutting Process and Oblique Cutting Process | Fundamentals of orthogonal and oblique machining | I | Online PPT/video | MTE-1/END SEM |

| | | | | | |
|---|---|---|---|---|---|
| **L7** | Mechanics of Orthogonal Metal Cutting | Chip thickness ratio, chip reduction coefficient, Shear angle, friction angle, cross-sectional area, volume of cut chip | I & II | Online PPT/video | MTE-1/END SEM Quiz |
| **L8** | Mechanics of Orthogonal Metal Cutting | Mass of cut chip, Shear strain, Velocity relationship, volume rate of | I | Online PPT/video | MTE-1/END SEM Quiz |
| | | chip, Shear train rate | | | |
| **L9** | Mechanics of Orthogonal Metal Cutting | Determination of cutting forces in turning process (Shear force, Fs, Normal force on shear plane Ns, Friction force F and resultant force etc. ) | I | Online PPT/video | MTE-1/END SEM Quiz |
| **L10** | Ernst and Merchant's Theory | Establishment a relation among shear angle $\beta$, rake angle $\gamma$ and friction angle $\eta$ | I | Online PPT/video | MTE-1/END SEM |
| **L11** | Merchant's Second Solution and Machining Constant | Establishment a relation among shear angle $\beta$, rake angle $\gamma$ and friction angle $\eta$ and concept of machining constant | I | Online PPT/video | MTE-1/END SEM Assignment |
| **L12** | Merchant's circle diagram | Drafting Method | I | Online PPT/video | MTE-1/END SEM |
| **L13** | Problems on Merchant's Theory | Determination of cutting forces and shear angle etc. | I | Online PPT/video | MTE-1/END SEM Assignment |
| **L14** | Lee and Shaffer's Theory | Relation between various parameters like rake angle, friction angle and shear angle in orthogonal cutting | I | Online PPT/video | MTE-1/END SEM Assignment |

| | | | | | |
|---|---|---|---|---|---|
| **L15** | Cutting Tool Materials | Various types of cutting tools used in machining process, viz. carbon & medium alloys steel, HSS, cast cobalt, carbides, ceramics, coated tools, cermet, sialon, CBN, diamond, Ucon, Whisker reinforced tool material | I & II | Online PPT/video | MTE-2/END SEM Quiz |
| **L16** | Cutting Fluids | Definition, function, requirements of good cutting fluid, accesses of cutting fluid to machining zone, main types of cutting fluids. | I & II | Online PPT/video | MTE-2/END SEM Assignment |
| **L17** | Tool wear | Factors affecting tool wear | I & II | Online PPT/video | MTE-2/END SEM Quiz |
| **L18** | Tool Life | Taylor's tool life equation and study of different factors affecting tool life | I | Online PPT/video | MTE-2/END SEM |

| | | | | | |
|---|---|---|---|---|---|
| **L19** | Lathe | Introduction, Types of Lathe, Accessories | II & III | Online PPT/video | MTE-2/END SEM |
| **L20** | Lathe Operations | Turning, Facing, Knurling, Parting, Drilling on lathe, Boring | II & III | Online PPT/video | MTE-2/END SEM Assignment |
| **L20** | Thread Cutting on Lathe | Concept of thread cutting, setting up pitch | III | Online PPT/video | MTE-2/END SEM Assignment for making thread |
| **L22** | Special Purpose lathe | Capstan and Turret lathe | III | Online PPT/video | MTE-2/END SEM Assignment |
| **L23** | Introduction to Shaper | Working mechanism and applications | III | Online PPT/video | MTE-2/END SEM |
| **L24** | Introduction to Planner | Working mechanism and applications | III | Online PPT/video | MTE-2/END SEM Quiz |
| **L25** | Shaping and Planning | Working mechanism and applications | III | Online PPT/video | MTE-2/END SEM |
| **L26** | Introduction to Milling | Working mechanism, types and applications | III | Online PPT/video | MTE-2/END SEM |
| **L27** | Milling Cutters | Various types of milling cutters such as, end milling cutters, peripheral milling cutters, slab milling etc. | III | Online PPT/video | MTE-2/END SEM Quiz |
| **L28** | Milling Operations | Mechanism of milling, chip formation and determination of cutting forces | III | Online PPT/video | MTE-2/END SEM Quiz |
| **L29** | Indexing | Introduction, need of indexing, various methods of indexing | II & III | Online PPT/video | MTE-2/END SEM Assignment |
| **L30** | Milling Problems | Indexing | II | Online PPT/video | MTE-2/END SEM Assignment |
| **L31** | Introduction to Drilling | Definition, working mechanism, types of drill machines | II | Online PPT/video | MTE-2/END SEM |
| **L30** | Drilling Mechanism | Geometry of drill bit, nomenclature of twist drill bit, various factors affecting drilling | I & II | Online PPT/video | MTE-2/END SEM Quiz |
| **L31** | Economics of Drilling | Drilling time estimation, Drilling force estimation and MRR | IV | Online PPT/video | MTE-2/END SEM Quiz |
| **L32** | Drilling Mechanism Problems | | IV | Online PPT/video | END SEM Assignment |
| **L33** | Reaming and Jig Boring | Working mechanism and applications | III | Online PPT/video | END SEM |
| **L34** | Grinding | Introduction, types of Grinding | II & III | Online PPT/video | END SEM |

| | | | | | |
|---|---|---|---|---|---|
| | | machines , Abrasive Material, Grain Size, | | | |
| **L35** | Grinding Wheel | Bonding Materials, Grinding wheel structure and grade Designation and Selection | I, II & III | Online PPT/video | END SEM Quiz |
| **L36** | Analysis of the Grinding Process | Speed determination, Material removal rate, Surface finish | II | Online PPT/video | END SEM Assignment |
| **L37** | Thermal Aspects of Grinding and wheel wear | Temperature at work surface, Attritious wear, Bond fracture, wear curve | IV | Online PPT/video | END SEM Qiz |
| **L38** | Honing Operation and Its Characteristics | Working mechanism and applications | III | Online PPT/video | END SEM |
| **L39** | Lapping & Super finishing operations | Working mechanism and applications | III | Online PPT/video | END SEM |
| **L40** | Super finishing operations | Burnishing, Magnetic float polishing, Magnetic field assisted polishing and Electro-polishing | III | Online PPT/video | END SEM Assignment/Quiz |
| **L41** | Broaching and Broaching Machine | Working mechanism and applications | III | Online PPT/video | END SEM |
| **L42** | Economics of Machining Operations | Machining time estimation, machining cost and economics | IV | Online PPT/video | END SEM Assignment |
| **L43** | Optimization in Machining | Optimizing Cutting parameters for minimum cost | IV | Online PPT/video | END SEM |
| **L44** | Optimization in Machining | Optimizing Cutting Parameters for Maximum Production | IV | Online PPT/video | END SEM |

**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 |
| I | Analyse Tool geometry and its attributes, Merchant circle diagram. Tool wear and Tool material. | 2 | 1 | 2 | 2 | 2 | | 1 | | | | | 1 | | | 1 |
| II | Relate concepts of Machining of components of various sizes and shapes with the help of workshop machines in real time machining environment. | 3 | 1 | 2 | 1 | 1 | | | 1 | | | | | | | 1 |
| III | Recognize the Operations, Types and Use of Machines like Lathe, Milling, and Drilling etc. | 2 | 2 | 1 | 2 | 1 | | | | | | | 1 | | | 2 |
| IV | Calculate machining time and metal removal rate. | 3 | 1 | | 2 | 1 | | | | | | | | | | 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
Production Technology II | ME1533 | 1 Credit | 0 0 2 1
Session: Aug 2020 – Dec 2020 | Faculty: Mr Ashish Goyal & Mr G S S Adithya |

**Class: B.Tech V$^{th}$ Semester**

**A. Introduction**: This course is offered by Dept. of Mechanical Engineering for 5$^{th}$ semester students, targeting students who wish to pursue research & development in industries or higher studies in field of machining and manufacturing, including study of various aspects of machine tools and also familiarize with hands-on training on lathe machine, milling machine, grinding machine and shaper machine. This course also offers introduction towards the advanced machining processes.

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

[ME1533.1] Recognize the Operations, Types and Use of Machines like Lathe, Milling, and Drilling for employability and skill enhancement.

[ME1533.2] Analyze and understand the working of Surface Grinding machine, Cylindrical Grinding Machine and shaper to improve the technical skills.

[ME1533.3] Comprehend the concepts of CNC and advanced machining processes for entrepreneurship.

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## 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.

## Program Specific Outcomes:

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

### D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Performance of Experiment, viva & lab record | 60 |
| | | |
| End Term Exam (Summative) | Lab 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 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 participation by a student will be assessed and marks will be awarded. | |

### E. Syllabus:

Preparing turning Models by using Lathe. Exercises involving plain turning, step turning, knurling, chamfering, taper turning, facing, free hand turning and "V" & Square thread cutting. Demonstrations on eccentric turning, internal threading, taper turning by taper turning attachment and tail stock set over method, Capstan and turret lathe etc., Milling Practice: Preparing milling models. Exercises on spur gear, helical gear, bevel gear, Slot milling; Shaping Practice: Preparing Shaping models. Shaping of flat surfaces, inclined surfaces, cutting of slots etc.; Grinding Practice: Exercises on Surface grinding and cylindrical grinding, Demonstrations on various advanced machines and machining operations.

### F. Text Books:

1. S.K.H. Choudhary and A.K.H. Choudhary, Elements of Workshop Technology Vol. 2, Media Promoters & Publications Pvt Ltd., 2010.

**G. References:**

1. B.S. Raghuvanshi, A course in Workshop Technology Vol. 2, Dhanpat Rai, 2015.

**H. Lecture Plan:**

**Production technology II Lab (ME1533)**

| Exp No | Experiments to be performed | Mode of delivery | Session Outcomes | Corresponding CO | Mode of assessing the outcome |
|---|---|---|---|---|---|
| Exp 1 | Study of Lathe machine and perform Facing, Turning, Step turning on a lathe machine | Performance | Demonstration of lathe machine tool | ME1533.1 | Viva & End exam |
| Exp 2 | Perform Grooving, Taper turning and chamfering operations on a lathe machine | Performance | Able to perform Operation on lathe machine | ME1533.1 | Viva & End exam |
| Exp 3 | Perform thread cutting and Knurling operations on a lathe machine & Study of Capstan and turret lathe. | Performance | Able to perform Operation on lathe machine | ME1533.1 | Viva & End exam |
| Exp 4 | Study of milling machine and its operational features & To produce a spur gear using milling machine | Performance | Demonstration of milling machine and able to perform operation | ME1533.1 | Viva & End exam |
| Exp 5 | To produce a helical & bevel gear on a milling machine. | Performance | Able to perform operation | ME1533.1 | Viva & End exam |
| Exp 6 | To produce flat surface on the work-piece as per required dimension, using shaper machine. | Performance | Able to perform operation | ME1533.1 | Viva & End exam |
| Exp 7 | To produce a inclined surface on the work-piece as per required dimension, using shaper machine | Performance | Able to perform operation | ME1533.1 | Viva & End exam |
| Exp 8 | To produce a “V” shape on work-piece as per required dimension, using shaper machine | Performance | Able to perform operation | ME1533.1 | Viva & End exam |
| Exp 9 | To perform surface grinding operation on a flat work-piece using surface grinding machine | Performance | Able to perform operation | ME1533.2 | Viva & End exam |
| Exp 10 | To perform external cylindrical grinding operation on a cylindrical work-piece using universal cylindrical grinding machine. | Performance | Able to perform operation | ME1533.2 | Viva & End exam |

| | | | | | |
|---|---|---|---|---|---|
| Exp 11 | Introduction to Computer Numerical Control (CNC) machine & to study principle - working of CNC machine. | Performance | Acquiring knowledge of CNC | ME1533.3 | Viva & End exam |
| Exp 12 | Introduction of advanced machining processes – Eg. AJM, LBM, EDM. | Performance | Acquiring knowledge of Advanced Machining Processes | ME1533.3 | Viva & End exam |

| CORRELATION WITH PROGRAM | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **STATEMENT** | OUTCOMES | | | | | | | | | | | | SPECIFIC OUTCOMES | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **[ME 1533.1]** | Recognize the Operations, Types and Use of Machines like Lathe, Milling, and Drilling for employability and skill enhancement. | 2 | 1 | 1 | 1 | 1 | | | | | | | 2 | | | 2 |
| **[ME 1533.2]** | Analyze and understand the working of Surface Grinding machine, Cylindrical Grinding Machine and shaper to improve the technical skills. | 2 | 1 | 1 | 1 | 1 | | | | | | | | | | 1 |
| **[ME 1533.3]** | Comprehend the concepts of CNC and advanced machining processes for entrepreneurship. | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | 1 |

# MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering Course Hand-out

Fluid Mechanics and Hydraulics Machines Lab| ME1534 | 1 Credits | 0 0 2 1

Session: Aug 20 – Dec 20 | Faculty: Ankur Srivastava and Alok Kumar Ansu | Class: B. Tech V Sem.

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering as lab course and is aimed at enabling the students experience the practical applications of theoretical concepts of Fluid Mechanics and Hydraulic Machines course. Hands on training is provided to students to acquaint them with the principles of Fluid Mechanics and Hydraulic Machines. This is beneficial for those who aim at pursuing research and higher studies in the relevant field. It also helps them in analysing the design aspects of some Fluid Mechanics equipment.

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

[1534.1] Understand the application of different rate laws of conduction, convection and radiation in measurement of certain quantities.

[1534.2] Interpret the experimental results and compare with the theoretical results. [1534.3] Experiment at different heat flux to get the desired result.

[1534.4] Recognize different design aspects of heat transfer equipment.

[1534.5] Analyse and explain the parameters which affect the performance of equipment which is based on principles of heat transfer.

**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].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Laboratory Sessions | 60 |

| | | |
|---|---|---|
| End Term Assesment (Summative) | Lab Exam Performance | 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 Practical End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a lab session will have to report to the teacher about the absence. The missed experiment can be performed as a makeup experiment in the next lab session or anytime before the laboratory exam | |
| Laboratory Guidelines | Students are expected to maintain an observation book and a laboratory record notebook. The experimental data should be noted in the observation book on the day of performance and the same should be transferred to the record notebook before the next lab. No students are allowed to enter the lab without the observation book and record book and attendance will be marked absent | |

**D. Syllabus**

Determination of Thermal Conductivity of Composite Walls, Determination of Thermal Conductivity of Insulating Powder, Determination of Heat Flow rate through Lagged Pipe, Determination of Thermal Conductivity of Metal Rod, Estimation of Heat Transfer Coefficient of a Pin Fin, Determination of Heat Transfer Rate through Natural Convection, Determination of Heat Transfer Rate through Forced Convection, Determination of Stefan Boltzmann's Constant, Calculation of Effectiveness in Parallel Flow Heat Exchangers and counter flow Heat Exchangers, Determination of emissivity of plate

**E. Reference Books**

R1. Fundamentals of Heat and Mass Transfer, Cengel, McGrawHill R2 Fundamentals of Heat and Mass Transfer

,Incorpera and Dewitt,

**F. Lecture Plan:**

| Lab No | **Name of the Experiment** | **Experiment Outcome** | **Type of Expt.** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | Introduction | To acquaint and clear teachers expectations and understand student expectations | Live Demo | NA | NA |
| 2 | Determination of Thermal Conductivity of Composite Walls. | To understand the significance of thermal conductivity | Hands On | [1534.1] | Observational Data, Viva-Voce |

| | | | | | |
|---|---|---|---|---|---|
| 3 | Determination of Thermal Conductivity of Insulating Powder. | To analyse the thermal conductivity of insulating material. | Hands On | [1534.1] | Observational Data, Viva-Voce |
| 4 | Determination of Heat Flow rate through Lagged Pipe. | To interpret the effect of composite material on overall heat transfer rate. | Hands On | [1534.3] | Observational Data, Viva-Voce |
| 5 | Determination of Thermal Conductivity of Metal Rod. | To understand the significance of thermal conductivity | Hands On | [1534.1] | Observational Data, Viva-Voce |
| 6 | Estimation of Heat Transfer Coefficient of a Pin Fin. | To differentiate between conduction and convection and understand use of rate laws | Hands On | [1534.5] | Observational Data, Viva-Voce |
| 7 | Determination of Heat Transfer Rate through Natural Convection. | To apply the concept of convection mechanism in natural convection. | Hands On | [1534.2] | Observational Data, Viva-Voce |
| 8 | Determination of Heat Transfer Rate through Forced Convection. | To apply the concept of convection mechanism in forced convection. | Hands On | [1534.2] | Observational Data, Viva-Voce |
| 9 | Determination of Stefan Boltzmann's Constant. | To understand the radiation effect on heat transfer rate. | Hands On | [1534.1] | Observational Data, Viva-Voce |
| 10. | Calculation of Effectiveness in Parallel Flow Heat Exchangers and counter flow Heat Exchangers. | To analyse the design aspects of heat transfer equipment. | Hands On | [1534.4] | Observational Data, Viva-Voce |
| 11. | Determination of emissivity of plate. | To understand the radiation effect on heat transfer rate. | Hands On | [1534.1] | Observational Data, Viva-Voce |

**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 |
| [1534.1] | Understand the application of different rate laws of conduction, convection and radiation in measurement of certain quantities. | 3 | | | | | | | 1 | | | | | | | |
| [1534.2] | Interpret the experimental results and compare with the theoretical results. | | | 2 | | | 1 | | | | | 2 | | | 1 | |
| [1534.3] | Experiment at different heat flux to get the desired result. | | | 1 | | | | | | | | | | 2 | | |
| [1534.4] | Recognize different design aspects of heat transfer equipment. | | | 3 | | | 2 | | 2 | 3 | | | | | | |
| [1534.5] | Analyse and explain the parameters which affect the performance of equipment which is based on principles of heat transfer. | | | | | | | | | 1 | 1 | | | | 3 | |

**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

Industrial Engineering | ME 1553 | 3 Credits | 3 0 0 3

Session: July 20 – Dec 20 | Faculty: Dr Ashish Goyal | Class: V Semester (Program Elective)

**A. Introduction**: This course is offered by Dept. of Mechanical Engineering for 5th Semester students, targeting students who wish to pursue research & development in industries or higher studies in field of Mechanical Engineering. It offers in depth knowledge of technical skills and intellectual discipline needed by our graduates to become leaders in industrial engineering and related professions. The course is distinctive in its emphasis on quantitative, economic, computer-aided approaches to production and service management problems. It is focused on providing an experimental and mathematical problem-formulating and problem-solving framework for industrial engineering work. The curriculum provides a broad foundation in the current ideas, models, and methods of industrial engineering.

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

**[ME 1553.1].** Understand the basic objectives, principles and techniques of industrial engineering and method study as well as various charts used in industries.

**[ME 1553.2].** Identify the applicable methods of work measurement and work sampling in the industries.

**[ME 1553.3].** Analyse the various techniques to measure and improve the productivity with optimized cost and quality for better employment in industries.

**[ME 1553.4].** Design the various analytical and tools to forecast the resources and demands of the industry.

**[ME 1553.5].** Design and apply the various techniques of scheduling jobs on machines along with the aggregate planning, master production schedule for employability in manufacturing 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.

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open/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. | |

## E. Syllabus:

Definition of Industrial Engineering: Objectives, Method study, Principle of motion economy, Techniques of method study - Various charts, THERBLIGS, Work measurement - various methods, time study PMTS, determining time, Work sampling. Productivity- Definition, Various methods of measurement, Factors effecting productivity, Strategies for improving productivity. Relevant costs, Costs of quality, Statistical quality Control (SQC), Variables & Attributes, Production Planning & Control (PPC): Introduction to Forecasting - Simple & Weighted moving average methods, Aggregate planning, Master production schedule (MPS), Sequencing- Johnson algorithm for n-Jobs-2 machines, n- Jobs-3 machines, n-Jobs m-machines.

## F. Text Books:

T 1. S.N. Chary, Production & Operations Management, McGraw Hill Publication, 4th Edition, 2009.
T 2. E. E. Adam, R. J. Ebert, Production and Operation Management: Concepts, Models, and Behaviour, Prentice Hall Publishers, 5th Edition, 1992.

## G. References:

C 1. S.S. Buffa, Modern Production Management, John Wiley Publication, 8th Edition, 2007.
C 2. P. Kumar, Industrial Engineering and Management, Pearson Publication, New Delhi, 1st Edition, 2015.

## H. Lecture Plan:

| Lecture Number | Topic to be covered | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| | Introduction and Course Hand-out briefing | To acquaint and clear teachers expectations and understand student expectations | Lecture/PPT | NA | NA |
| L1 | Definition of Industrial Engineering | Student will able to understand the application of industrial engineering | Lecture/PPT | ME1553.1 | Quiz<br>Mid term I<br>Assignment |
| L2 | Method study | Able to understand various manufacturing processes | Lecture/PPT | ME1553.1 | Quiz<br>Mid term I |
| L3 | Method study processes | Distinguish between various manufacturing processes | Lecture/PPT | ME1553.1 | Quiz<br>End term<br>Assignment |
| L4 | Principle of motion economy | Knowledge about use of various tools. | Lecture/PPT | ME1553.1 | Quiz<br>Mid term I |
| L5 | Principle of motion economy | Understand the use of hand body movements | Lecture/PPT | ME1553.1 | Quiz<br>Mid term I |
| L6 | Techniques of method study - | Understand the flow of material | Lecture/PPT | ME1553.1 | Quiz<br>Assignment<br>End term |

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|---|---|---|---|---|---|
| | Various charts | | | | |
| L7 | Techniques of method study - Various charts | Understand the movement of worker on shop floor. | Lecture/PPT | ME1553.1 | Quiz<br>Mid term I |
| L8 | THERBLIGS | Able to explain various therblings symbols | Lecture/PPT | ME1553.1 | Quiz<br>End term |
| L9 | THERBLIGS | Record the figure movements | Lecture/PPT | ME1553.1 | Quiz<br>Mid term I |
| L10 | Work measurement - various methods | Identify different methods of work measurement | Lecture/PPT | ME1553.2 | Quiz<br>End term<br>Assignment |
| L11 | Time study | Examine the standard time calculation | Lecture/PPT | ME1553.2 | Quiz |
| L12 | Time study | Learn about the performance rating and allowances | Lecture/PPT | ME1553.2 | Quiz<br>Mid term I |
| L13 | PMTS | Discuss and understand the function of PMTS | Lecture/PPT | ME1553.2 | Quiz |
| L14 | Work sampling | Measure to calculate the standard time with taking random observation | Lecture/PPT | ME1553.2 | Quiz<br>Assignment |

| | | | | | |
|---|---|---|---|---|---|
| L15 | Productivity | Understand the comparison of Input and output | Lecture/PPT | ME1553.3 | Quiz<br>Mid term I |
| L16 | Various methods of measurement of Productivity | Recall methods to calculate partial productivity | Lecture/PPT | ME1553.3 | Quiz |
| L17 | Factors effecting productivity | Learn about the use of 3M for productivity improvement | Lecture/PPT | ME1553.3 | Quiz<br>End term |
| L18 | Strategies for improving productivity | Recall various strategies for improving productivity | Lecture/PPT | ME1553.3 | Quiz<br>Mid term I |
| L19 | Relevant costs | Learn about relevant cost associated with quality | Lecture/PPT | ME1553.3 | Quiz<br>Mid term I |
| L20 | Costs of quality | Able to solve problems to examine cost of quality | Lecture/PPT | ME1553.3 | Quiz<br>End term |
| L21 | Statistical quality Control (SQC) | Understand the various SQC tool | Lecture/PPT | ME1553.3 | Quiz<br>Assignment |
| L22 | Statistical quality Control (SQC) | Able to apply SQC tools for manufacturing industries | Lecture/PPT | ME1553.3 | Quiz<br>End term |
| L23 | Variables & Attributes | Able to understand about assignable | Lecture/PPT | ME1553.3 | Quiz<br>Mid term I |

| | | | | | |
|---|---|---|---|---|---|
| | | and chance cause of variation | | | |
| L24 | Production Planning & Control (PPC) | Understand the production, planning and production control | Lecture/PPT | ME1553.3 | Quiz<br>End term |
| L25 | Production Planning & Control (PPC) | Learn about various functions of PPC | Lecture/PPT | ME1553.3 | Quiz<br>Mid term II |
| L26 | Forecasting | Apply the knowledge to forecast of NPD | Lecture/PPT | ME1553.4 | Quiz<br>Assignment |
| L27 | Simple & Weighted moving average methods | Able to forecast future demand | Lecture/PPT | ME1553.4 | Quiz<br>Mid tem II |
| L28 | Simple & Weighted moving average methods | Able to forecast future demand | Lecture/PPT | ME1553.4 | Quiz<br>Assignment<br>End term |
| L29 | Aggregate planning | Learn the various planning methods | Lecture/PPT | ME1553.5 | Quiz |
| L30 | Aggregate planning | Able to determine intermediate planning and line balancing | Lecture/PPT | ME1553.5 | Quiz<br>End term |
| L31 | Master production | Describe various factors MPS | Lecture/PPT | ME1553.5 | Quiz<br>Mid tem II |

| | | | | | |
|---|---|---|---|---|---|
| | schedule (MPS) | | | | |
| L32 | Master production schedule (MPS) | Understand about the individual product planning to be produced | Lecture/PPT | ME1553.5 | Quiz<br>Assignment |
| L33 | Sequencing - Johnson algorithm | Solve the problems based on Johnson algorithm | Lecture/PPT | ME1553.5 | Quiz |
| L34 | n-Jobs-2 machines | Able to apply the knowledge to arrange jobs and machines for make span time | Lecture/PPT | ME1553.5 | Quiz<br>End term |
| L35 | n-Jobs-2 machines | Able to apply the knowledge to arrange jobs and machines for make span time | Lecture/PPT | ME1553.5 | Quiz<br>Assignment |
| L36 | n- Jobs-3 machines | Able to apply the knowledge to arrange jobs and machines for make span time | Lecture/PPT | ME1553.5 | Quiz<br>Mid term II |
| L37 | n- Jobs-3 machines | Able to apply the knowledge to arrange jobs and machines for make span time | Lecture/PPT | ME1553.5 | Quiz<br>End term II |
| L38 | n-Jobs m-machines. | Able to apply the knowledge to arrange jobs and | Lecture/PPT | ME1553.5 | Quiz |

| | | | | | |
|---|---|---|---|---|---|
| | | machines for make span time | | | |
| L39 | Conclusion and Course Summarization | NA | NA | NA | NA |

## I. 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 |
| **[ME 1553.1]** | Understand the basic objectives, principles and techniques of method study as well as various charts used in industries. | | | | 2 | 1 | | | | 1 | 1 | 3 | 1 | | | |
| **[ME 1553.2]** | Identify the applicable methods of work measurement and work sampling in the industries. | | 1 | 2 | 1 | 1 | | | | | | 2 | 1 | | | |
| **[ME 1553.3]** | Analyse the various techniques to measure and improve the productivity with optimized cost and quality for better employability in industries. | 1 | 1 | 1 | 2 | 2 | | | 1 | 2 | 1 | 3 | 1 | | | |
| **[ME 1553.4]** | Design the various analytical and tools to forecast the resources and demands of the industry. | | 1 | 1 | 2 | 1 | | | | 1 | 1 | 2 | 1 | | | |
| **[ME 1553.5]** | Design and apply the various techniques of scheduling jobs on machines along with the aggregate planning, master production schedule for | 1 | 1 | 1 | 2 | 2 | | | | 2 | 1 | 3 | 1 | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | employability in manufacturing industries. | | | | | | | | | | | | | | | |

A. **Introduction:** This course is an application of many other courses. These other courses include: Applied Mechanics; Fluid Mechanics; Thermodynamics; Machine Design and Strength of Materials. The course aims at giving an overview of different types of turbo-machinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic, steam and gas-turbines. It will focus on applications in power generation, transport, refrigeration and the built environment.

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

**[ME 1555.1]** Recognize typical designs of turbomachines and understand the working principles of turbomachines and apply it to various types of machines

**[ME 1555.2]** Apply the conservation equations of mass, momentum, and energy to evaluate the performance of turbo machine components.

**[ME 1555.3]** Visualize dimensional analysis which will enhance their skill to discuss today's and tomorrow's use of turbomachines for enabling a sustainable employability.

**[ME 1555.4]** Determine the velocity triangles and perform the preliminary design of turbomachines (turbine, compressors, and Fans).

**[ME 1555.5]** Recognize relations between choices made early in the turbomachinery design process and the final components and operability.

## 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.

**PROGRAM SPECIFIC OUTCOMES:**

**[PSO.1].** Model and analyse mechanical engineering components using advanced software.

**[PSO.2].** Analyse performance of I. C. engines attributed to alternate fuels.

**[PSO.3].** Synthesize advance materials for mechanical engineering applications.

## D. Assessment Rubrics:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | Quizzes (Open Book/Close Book) and Assignments | 30 |
| 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/ (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

Basic Concepts of Turbo Machines: Basic laws and governing equations, continuity equation, steady flow energy equation, Newton's 2nd law of motion applied to turbomachines - Euler's pump equation and Euler's turbine equation, dimensional analysis applied to hydraulic machines, power coefficient, flow coefficient, head coefficient, non-dimensional specific speed, Dimensional analysis applied to compressible flow machines. Centrifugal Turbine and Fans: Velocity diagrams, slip factor, energy transfer, power input factor, stage pressure rise and loading coefficient, pressure coefficient, degree of reaction, Centrifugal compressor characteristic, surging, rotating Stall and Choking. Axial Flow Turbine and Fans, turbine versus compressor blades, Axial flow compressors, working principle, velocity triangle, stage work, work done factor, stage loading, degree of reaction; vortex theory, Introduction to blade design, cascade test, compressibility effects, operating characteristics.

## F. Text Book:

T1. A.T. Sayers, Hydraulic & Compressible flow Turbomachines, McGraw Hill Publication, 1990.
T2. S.L. Dixon, Fluid Mechanics, Thermodynamics of Turbomachinery, Pergamon, 2006.

## G. Reference Book:

R1. S.M. Yahya, Turbomachines, Satya Prakashana, New Delhi, 2005.
R2. S.M. Yahya, Turbines Compressors and Flans, McGraw Hill Publication, 2005.

## H. Lecture Plan:

| Lec No | **Topics** | **Session Objective** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | Course Hand-out briefing | To acquaint teacher’s expectations and understand student expectations | Lecture | NA | NA |
| 2 | Introduction to Turbo Machines | Know the basics of the course and understand its applications | Lecture/PPT | ME1555.1 | Class Quiz/Mid Term I |
| 3 | Review of Fluid Mechanics | Brief about the basics of Fluid mechanics | Lecture/PPT | ME1555.2 | Class Quiz/Mid Term I |
| 4 | Basic laws and governing equations | Brief about the basics of Fluid mechanics, laws and governing equations | Lecture/PPT | ME1555.2 | Home Assignment and Mid-Term I End-Term |

| | | | | | |
|---|---|---|---|---|---|
| 5 | Continuity equation | Understand the flow of energy | Lecture/PPT | ME1555.2 | Home Assignment and Mid-Term I End-Term |
| 6 | Steady flow energy equation | | | | |
| 7 | Newton's 2nd law of motion applied to turbomachines | Brief about the thermodynamics and Know the genesis Newton's 2nd law | Lecture/PPT | ME1555.1 ME1555.2 | Home Assignment and Class Quiz Mid-Term II End-Term |
| 8 | Euler's pump equation | Use of Euler's equation for turbo machinery | Lecture/PPT | ME1555.1 ME1555.2 | |
| 9 | Euler's turbine equation | Use of Euler's equation for turbo machinery | Lecture/PPT | ME1555.1 ME1555.2 | |
| 10 | Review and Class Quiz | Assessment and Revision of concepts | | NA | NA |
| 11 to 13 | Dimensional analysis applied to hydraulic machines | Understand the dimensional analysis and performance parameters | Lecture/PPT | ME1555.1 ME1555.3 | Home Assignment and Class Quiz Mid-Term II End-Term |
| 14 & 15 | Dimensional analysis applied to compressible flow machines | | | ME1555.1 ME1555.3 | |
| 16 | Centrifugal Turbine and Fans (I) | Analyse the Velocity diagrams, | Lecture/PPT | ME1555.1 ME1555.4 | Home Assignment and Class Quiz Mid-Term II End-Term |
| 17 | Centrifugal Turbine and Fans (II) | Analyse the slip factor, and energy transfer | | ME1555.1 ME1555.4 | |
| 18 | Centrifugal Turbine and Fans (III) | Analyse the power input factor, stage pressure rise and | Lecture/PPT | ME1555.1 ME1555.4 | |
| 19 | Centrifugal Turbine and Fans (IV) | Analyse the loading coefficient, pressure coefficient, degree of reaction. | Lecture/PPT | ME1555.1 ME1555.4 | |
| 20 | Review and Class Quiz | Assessment and Revision of concepts | Lecture/PPT | NA | NA |
| 21 | Characteristic of Centrifugal | Know the genesis of | Lecture/PPT | ME1555.1 ME1555.4 | Home Assignment |

| | | | | | |
|---|---|---|---|---|---|
| | compressor | centrifugal compressor | | | and Class Quiz Mid-Term II End-Term |
| 22 | Centrifugal compressor | Understand the surging, rotating Stall and Choking of centrifugal compressor | Lecture/PPT | ME1555.1 ME1555.4 | |
| 23 | Centrifugal compressor continues. | | | | |
| 24 | Axial Flow Turbine | Explain the axial flow turbine and fans | Lecture/PPT | ME1555.1 ME1555.4 | |
| 25 | Fans | | | | |
| 25 & 26 | Turbine versus compressor blades | Differentiate turbine and compressor blades | Lecture/PPT | ME1555.1 ME1555.4 | Home Assignment and Class Quiz End-Term |
| 27 | Axial flow compressors (I) | Explain the working principle of axial flow compressor | Lecture/PPT | ME1555.1 ME1555.4 | |
| 28 | Axial flow compressors (II) | analyse velocity triangle | Lecture/PPT | ME1555.1 ME1555.4 | |
| 29 | Axial flow compressors (III) | Analyse the stage work, work done factor, stage loading, | Lecture/PPT | ME1555.1 ME1555.4 | |
| 30 | Axial flow compressors (IV) | Analyse the degree of reaction; vortex theory | Lecture/PPT | ME1555.1 ME1555.4 | |
| 31 | Introduction to blade design | Know the genesis of blade design | Lecture/PPT | ME1555.1 ME1555.5 | Class Quiz |
| 32 | Cascade test | Understand Cascade test | Lecture/PPT | ME1555.5 | Home Assignment and Class Quiz End-Term |
| 33 | compressibility effects | Describe the compressibility effects | Lecture/PPT | ME1555.5 | |
| 34 & 35 | operating characteristics | Recall operating characteristics | Lecture/PPT | ME1555.5 | |
| 36 | Revision | Quiz | Lecture/PPT | | |

**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 |
| ME1555.1 | Recognize typical designs of turbomachines and understand the working principles of turbomachines and apply it to various types of machines | 3 | 3 | 3 | 3 | | | | | | | | | | | |
| ME1555.2 | Apply the conservation equations of mass, momentum, and energy to evaluate the performance of turbo machine components. | 3 | 3 | | | | | | | | | | | | | |
| ME1555.3 | Visualize dimensional analysis which will enhance their skill to discuss today's and tomorrow's use of turbomachines for enabling a | 3 | 2 | | 2 | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | sustainable employability. | | | | | | | | | | | | | | | |
| ME1555.4 | Determine the velocity triangles and perform the preliminary design of turbomachines (turbine, compressors, and Fans). | 3 | | | | | | | | | | | | | | |
| ME1555.5 | Recognize relations between choices made early in the turbomachinery design process and the final components and operability. | 3 | 3 | | | | | | | | | | | | | |

**MANIPAL UNIVERSITY JAIPUR**

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

Composite Materials | ME 1556 | 3 Credits | 3 0 0 3

Session: July – Dec 2020-21 | Faculty: Dr. Subrata B Ghosh | Class: B. Tech. III Year

**A. INTRODUCTION:** This course is offered by Department of Mechanical Engineering as programme elective. Students will learn how composite materials are designed, processed and manufactured. This course will discuss the influencing parameters and structure-property correlations in particulate, fibre, structural composites, biocomposites and nanocomposites, It will help understand the subject with ease by presenting the content in a simplified and logical sequence. It will aid the teaching learning process through relevant illustrations, animations, web content and practical examples. The course will highlight important concepts for each topic covered in the subject. Finally this course will provide opportunity of self-evaluation on the understanding of the subject matter.

**B. COURSE OUTCOMES:** At the end of the course, students will

**[1556.1]** The aim is to explain the basic fundamentals of composite materials.
**[1556.2]** This course will familiarize the students with various composite materials from the viewpoint of applications, properties, characterisations and performance improvements.
**[1556.3]** This course will discuss the influencing parameters and structure-property correlations in various composite materials.
**[1556.4]** This course will also combine particulate, fibre, structural composites, biocomposites and nanocomposites. Composites micromechanics, advanced inspection and nondestructive testing (NDT) of composite parts supported with various case studies will also be covered.

## 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 understanding 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.

**Programme Specific Outcomes:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. ASSESSMENT PLAN

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I | 15 |
| | Sessional Exam II | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| 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

Definition and Classification of Composites.

Reinforcing fibres- Natural fibres (cellulose, jute, coir etc), boron, carbon, ceramic glass, aramids, etc. Short and continuous fibre reinforced composites. Particulate fillers-importance of particle shape and size.

Matrix resins-thermoplastics and thermosetting matrix resins. Coupling agents-surface treatment of fillers and fibres, significance of interface in composites.

Fabrication techniques pultrusion, filament winding, prepreg technology, injection and compression moulding, resin transfer moulding, reaction injection moulding etc.

Biocomposites, Nanocomposites

Micromechanics of composites. Properties and performance of composites. Applications. Mechanisms of fracture in composites.

Property evaluation and NDT of composites.

**Prescribed Text Book**

T1. F.L. Matthews and R.D. Rawlings, Composite Materials: Engineering and Science, Chapman & Hall, London.

**Reference Books**

R1. K.K. Chawla, Composite Materials – Science & Engineering, Springer-Verlag, New York.

R2. Carlsson, L. A., Pipes, R.B., Experimental Characterization of Advanced Composite Materials, Prentice-Hall, Inc., New Jersey.

R3. L., E. Nielsen and R. F. Landel, Mechanical Properties of Polymer and Composites, Marcel Dekker Inc.

R4. Lecture notes

## F. LECTURE PLAN

| Lecture | Topic | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| **L1** | Introduction, Scope and Objectives of the Course | To acquaint and clear teachers expectations and understand student expectations | Lecture/PPT | **[1556.1]** | NA |
| **L2** | Classification of Composite Materials | Students will understand the importance of 'Composite Materials' | Lecture/PPT | **[1556.1]** | Mid-Term 1<br>Quiz |
| **L3-L4** | Designing with Composites | Students will be able to understand different design strategies | Lecture/PPT | **[1556.2]** | Quiz |
| **L5-L6** | Polymer Matrix Resins- Thermoplastics and Thermosetting resins | Discussion on different types of polymer matrices | Lecture/PPT | **[1556.2]** | Mid-Term 1<br>Quiz |
| **L7-L9** | Metal Matrix Composites, Ceramic Matrix Composites | Discussion on different types of metal matrices | Lecture/PPT | **[1556.2]** | Assignment |
| **L10-L11** | Reinforcing Fibres- Synthetic and Natural Fibres | Discuss different types of reinforcements | Lecture/PPT | **[1556.2]** | Mid-Term 1<br>Quiz |
| **L12-L13** | Short and Continuous Fibre Reinforced Composites | Understand effect of various short and continuous fibre reinforcements | Lecture/PPT | **[1556.3]** | Mid-Term 1 |

| | | | | | |
|---|---|---|---|---|---|
| **L14** | Particulate Fillers-Importance of Particle Shape and Size | Students will understand effect of different types of particulate fillers | Lecture/PPT | **[1556.3]** | Quiz |
| **L15** | Concepts Check, Numericals, Problem Solving | Problem Solving | Lecture/PPT | **[1556.3]** | Mid-Term 1 |
| **L16-L17** | Structural Reinforcements: Fabric Reinforcements | Students will understand about various types of structural reinforcements. | Lecture/PPT | **[1556.3]** | Quiz |
| **L18** | Sandwich Construction | Students will understand effect of dislocations and their effects. | Lecture/PPT | **[1556.3]** | Mid-Term 1<br>Quiz |
| **L19** | Concepts Check, Numericals, Problem Solving | Problem Solving. | Lecture/PPT | **[1556.3]** | Mid-Term 1<br>Quiz |
| **L20** | Interfacial Adhesion | Students will understand importance of interfacial adhesion | Lecture/PPT | **[1556.3]** | Mid-Term 1<br>Quiz |
| **L21-L22** | Composite Manufacturing Processes-Fabrication Techniques | Learn about various manufacturing processes of composites | Lecture/PPT | **[1556.3]** | Mid-Term 1<br>Quiz |
| **L23-L25** | Characterization Techniques of Composites | Learn about various characterization techniques | Lecture/PPT | **[1556.3]** | Mid-Term 1<br>Quiz |
| **L26** | Concepts Check, Numericals, Problem Solving | Problem Solving | Lecture/PPT | **[1556.3]** | Mid-Term 1<br>Quiz |
| **L27** | Quiz 1 and Assignment topics | Learn about overall composites manufacturing | Lecture/PPT | **[1556.3]** | Quiz |
| **L28-L30** | Micromechanics of Composites | Understand composite micromechanics to evaluate composite properties | Lecture/PPT | **[1556.3]** | Quiz & Assignment |
| **L31-L32** | Biocomposites-Materials Selection and Design considerations | Learn about various biocomposites, properties, applications, manufacturing | Lecture/PPT | **[1556.3]** | Mid-Term 2 |
| **L33** | Nanocomposites-Opportunities and Challenges | Students will learn importance of various nanocomposites | Lecture/PPT | **[1556.3]** | Mid-Term 2 |
| **L34-L36** | Properties and Performance of Composites | Learn about various properties of composites | Lecture/PPT | **[1556.3]** | Quiz |

| | | | | | |
|---|---|---|---|---|---|
| **L37** | Concepts Check, Numericals, Problem Solving | Problem Solving. | Lecture/PPT | **[1556.3]** | Mid-Term 2 |
| **L38** | Applications of Composite Materials | Understand various metal fabrication techniques. | Lecture/PPT | **[1556.3]** | Mid-Term 2 |
| **L39-L40** | Inspection and Testing of Composites | Learn about various NDT techniques used in composites | Lecture/PPT | **[1556.3]** | Mid-Term 2 |

## 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 |
| **[1556.1]** | The aim is to explain the basic fundamentals of composite materials. | 3 | | 1 | | 2 | 3 | 1 | 1 | 1 | | 1 | 2 | 3 | 2 | 1 |
| **[1556.2]** | This course will familiarize the students with various composite materials from the viewpoint of applications, properties, characterisations and performance improvements. | 3 | 1 | 1 | | 2 | 1 | | 1 | | 1 | 1 | 1 | 2 | 3 | 2 |
| **[1556.3]** | This course will discuss the influencing parameters and structure-property correlations in various composite materials. | 3 | 2 | | 1 | 1 | 2 | 1 | | 2 | 2 | 1 | | 1 | 1 | 3 |
| **[1556.4]** | This course will combine particulate, fibre, structural composites, biocomposites and nanocomposites. Composites micromechanics, advanced inspection and nondestructive testing (NDT) of composite parts supported with various case studies will also be covered. | 3 | 1 | 1 | | 1 | 1 | 1 | | 1 | 2 | | 2 | 1 | 2 | 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

Machine Design - II | ME 1605 | 4 Credits | 4 0 0 4

Session: Jan 21 – May 21 | Faculty: Prof. Sasanka Sekhar Ghosh/ Dr. Santosh Patil/ Dr. Ashish Sruvastava

**A. INTRODUCTION:** This course is offered by Dept. of Mechanical Engineering, targeting students who wish to understand analysis and design of important machine elements, pursue research & development in industries or higher studies in field of Mechanical Engineering, including advanced basics of machine element designing including the design process, engineering mechanics and materials, failure prevention under static and variable loading for different elements like springs, gears (Spur, Helical), bearings (journal and anti-friction). This course offers in depth knowledge of practical approach through a wide range of applications and examples of design and analysis. Subject provide the knowledge to formulate the problem, generation of machine element by standard methods and data sheets, based upon previously learned failure criteria.

**B. COURSE OOUCOMES:** At the end of the course, students will be able to

| | |
|---|---|
| **[ME 1605.1]** | Select the proper spring, spring arrangement and design various type of springs (Helical Compression, multileaf) for static and fluctuating load. |
| **[ME 1605.2]** | Analyse load and design of Gear (spur, helical etc.) |
| **[ME 1605.3]** | Compute equivalent radial loads for rolling contact bearing & select appropriate bearing for the application. |
| **[ME 1605.4]** | Analyse the pressure distribution and design of journal bearing. |
| **[ME 1605.5]** | Analyse and design of belt drives , rope drive and chain drive. |

## 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.

**Programme Specific Outcomes**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. ASSESSMENT PLAN:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | In class Quizzes and Assignments, NPTEL course performance, Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open 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 3 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. Spring design: introduction and spring materials. Design of Helical springs for static and fluctuating loads, buckling of compression springs.
2. Gear design: introduction, Gear manufacturing and Gear materials, load analysis on gear tooth, Calculation of Virtual number of teeth and Contact Ratio, Stresses on gears. Lubrication of Gearings.
3. Bearing and Lubrication: Introduction of Bearings, Bearing load life at rated reliability and section of Antifriction Bearings. Lubrication for Antifriction Bearing, mounting and enclosures.
4. Journal Bearing: Types of journal bearings and lubrications, Material combination in Journal bearings, Hydrodynamic lubrication theory, Design of Hydrodynamic bearings and Non-conforming Contacts.
5. Design of Flexible Mechanical elements: Introduction, design of flat belt and V- belt, design of flywheel wire rope design. Design of chain drives.

## F. TEXT BOOK:

1. J.E. Shigley and C.R. Mischke, Mechanical Engineering Design, McGraw Hill Publication, 7th Edition, 2003.
2. V. B. Bhandari, Design of Machine Elements, McGraw Hill Education (India) Pvt. Ltd.

## G. REFERENCE BOOKS:

1. R. L. Norton, Machine Design-An Integrated Approach, Pearson Publisher, 5th Edition, 2013.
2. U.C. Jindal, Machine Design, Pearson publisher, 1st Edition, 2010.
3. V. B. Bhandari, Machine Design Data book, McGraw Hill Education (India) Pvt. Ltd.

## H. LECTURE PLAN:

| Lec No | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | Introduction. | To acquaint and clear teachers expectations and understand student expectations | Lecture | NA | Class Quiz<br>Mid Term I |
| 2 | Type of Springs and Connection of spring series and Parallel. Stresses and Deflection in Helical springs. | Recall working of springs, how deformation takes place | Flipped Classroom | 1605.1 | In Class Quiz ( Not Accounted) |

| | | | | | |
|---|---|---|---|---|---|
| 3,4 | Compression Springs. | Identify different types of compression springs | Lecture | 1605.1 | In Class Quiz<br>End Term |
| 5,6 | Spring Materials | Explain about spring material and its uses | Self-Study/ PPT | 1605.1 | Home Assignment<br>End Term |
| 7 | Design of Helical Springs, Critical frequency of Helical Springs | Using the standard procedure design helical gears and find out its critical frequency | Lecture | 1605.1 | In Class Quiz<br>End Term |
| 8,9 | Fatigue Loading On spring, | Recall and discuss about endurance limit, design for fatigue loading | Activity (Think Pair Share) | 1605.1 | Class Quiz<br>Mid Term I<br>End Term |
| 10,11, 12 | Problems on Spring (Numerical, Doubts), leaf spring | Solve numerical problems based on design of spring | Activity (Jigsaw) | 1605.1 | Class Quiz<br>Mid Term I<br>End term |
| 13, 14 | Types and Nomenclature of gears , Conjugate action and Involute Properties, Fundamentals of gears | Recall law of gearing, nomenclature and discuss about the involute and cycloidal tooth profile | Flipped Class | 1605.2 | Home Assignment<br>Class Quiz<br>Mid Term I<br>End Term |
| 14,15 | Forming of gear teeth and Interferences, manufacturing of gears, Gear trains, Numerical Problems, gear material | Discuss about gear manufacturing process, recall gear train and some problem based on gear train | Activity (Think Pair Share) | 1605.2 | Class Quiz<br>Mid Term I<br>End Term |
| 16, 17 | Spur Gear- Static Force analysis on gears teeth | Analyse and discuss about force which acts on gear teeth | Lecture | 1605.2 | Class Quiz<br>Mid Term I<br>End Term |
| 18 | Analyses of strength of gear teeth | Interpret and analyse the beam strength of gears | Lecture | 1605.2 | Class Quiz<br>Mid Term I<br>End Term |
| 19 | Dynamic Effects of forces on gear teeth | Examine the dynamic effects of force on gear teeth | Jigsaw | 1605.2 | Class Quiz<br>Mid Term I<br>End Term |
| 20,21 | Estimation of Gear size, Fatigue Strength and consideration of Factor of safety, Surface durability and surface Fatigue strength | Evaluate the gear dimension, fatigue strength, FoS and surface durability of beam strength | Lecture, Activity | 1605.2 | Class Quiz<br>Mid Term I<br>End Term |
| 22,23 | Heat dissipation , Discussion | Describe working heat dissipation in gears | Lecture, Activity | 1605.2 | Class Quiz<br>Mid Term II<br>End Term |
| 24,25 | Helical Gear, Terminology of Helical Gear, Virtual number of teeth | Recall the gear nomenclature and calculate the virtual number of teeth | Lecture | 1605.2 | Class Quiz<br>Mid Term II<br>End Term |
| 26,,27,28 | Force Analysis, beam strength of Helical gears | Describe the working of forces, evaluate the beam strength of gears | Lecture | 1605.2 | Class Quiz<br>End Term |
| 29,30 | Effective load on gear tooth, wear strength of Helical gears | Evaluate the effective load on gears as well as its wear strength | Flipped Class | 1605.2 | Class Quiz<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| 31 | Introduction of Bearings and types of bearings | Describe the working and types of bearings | Flipped Class | 1605.3 | Class Quiz<br>End Term |
| 32, 33 | Life analysis of Ball bearing and roller contact bearing. | Examine the life of a ball and roller contact bearing | Flipped Class | 1605.3 | Class Quiz<br>End Term |
| 34 | Load analysis of Ball bearing and roller contact bearing. | Evaluate the load of ball and roller bearing | Flipped Class | 1605.3 | Class Quiz<br>End Term |
| 35,36 | Selection of Ball and roller contact bearing. | Describe the selection procedure of ball and roller bearings | Flipped Class | 1605.3 | Class Quiz<br>End term |
| 37 | Lubrication and Mounting and enclosure. | Identify different types of lubricants, mounting and enclosure | Lecture | 1605.3 | Class Quiz<br>Mid Term II<br>End Term |
| 38,39 | Viscosity and Petroff's Law. | Discuss about viscosity of a fluid and describe the Petroff;s law | Flipped Classroom | 1605.4 | Class Quiz<br>Mid Term II<br>End Term |
| 40 | Stable Lubrication and Thick Film Lubrication. | Examine stable and thick film lubrication and discuss the influence of lubrication | Flipped Classroom | 1605.4 | Class Quiz<br>Mid Term II<br>End Term |
| 41,42 | Hydrodynamic theory and Design Consideration. | Describe hydrodynamic theory and discuss the design consideration | Flipped Classroom | 1605.4 | Class Quiz<br>End Term |
| 43,44 | Bearing Performance | Describe about the performance of bearing | Flipped Classroom | 1605.4 | Class Quiz<br>End Term |
| 45,46 | Design of Belt drive | Discuss the design procedure of belt drives | Flipped Classroom | 1605.5 | Class Quiz<br>End Term |
| 47 | Analysis of Belt tension | Analyse the effect of tension in belt drive | Flipped Classroom | 1605.5 | Class Quiz<br>End Term |
| 48 | Condition for Maximum power | Evaluate the condition for maximum power transmission | Lecture, Activity | 1605.5 | Class Quiz<br>Mid Term II<br>End Term |
| 49,50 | Selection of Flat-belts Design of Flat belt drives | Discuss the selection procedure of flat belt drives | Lecture, Activity | 1605.5 | Class Quiz<br>Mid Term II<br>End Term |
| 51,52 | Selection of V-belts, numerical | Describe the selection procedure of V belt drive | Lecture | 1605.5 | Class Quiz<br>Mid Term II<br>End Term |
| 53,54 | Chain drive | Discuss in brief about chain drive | Flipped Classroom | 1605.5 | Class Quiz<br>End Term |
| 55 | Sprocket wheels ,Chain lubrication | Recall about the lubrication and sprocket wheels working procedure | Lecture, Activity | 1605.5 | Class Quiz<br>Mid Term II<br>End Term |
| 56 | Rope, types, specification, design of rope drive | Describe about rope drive and analyse the design procedure of rope drive | Lecture, Activity | 1605.5 | Class Quiz<br>Mid Term II<br>End Term |

**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 |
| **[ME 1605.1]** | Select the proper spring, spring arrangement and design various type of springs (Helical Compression, multileaf) for static and fluctuating load. | 2 | 2 | 3 | 3 | 1 | 1 | | | | | | | 1 | | |
| **[ME 1605.2]** | Analyse load and design of Gear (spur, helical etc.) | 3 | 3 | 3 | 3 | 1 | 1 | | | | | | | 1 | | |
| **[ME 1605.3]** | Compute equivalent radial loads for rolling contact bearing & select appropriate bearing for the application. | 3 | 3 | 3 | 3 | 1 | 1 | | | | | | | | | |
| **[ME 1605.4]** | Analyse the pressure distribution and design journal bearings. | 3 | 3 | 3 | 3 | 1 | 1 | | | | | | | | | |
| **[ME 1605.5]** | Analyse and design of belt drives , rope drive and chain drive. | 2 | 2 | 3 | 3 | 1 | 1 | | | | | | | 1 | | |

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

**Internal Combustion Engine | ME 1606| 4 Credits | 3 1 0 4**

**Session: Jan-June 21 | Faculty: Dr. Abhishek Sharma/ Mr. Sumit Taneja/Dr. Shashi Bhushan | Class: B. Tech. III Year**

**A. Introduction:** Perhaps the invention of the engine, or even introducing its concept, was the most important scientific event in the human history. Replacing the horse carriage by the automobile or the horse-less carriage, as it was initially called, was an event that increased the distance human beings can endeavour into space. After completing this course, students will have a broad and fundamental understanding of Internal Combustion Engines. Topics range from an overview of IC Engines and its different types of combustion process in SI Engine and CI Engine, normal combustion and abnormal combustion and performance evaluation of IC Engine, heat balance sheet, alternative fuels will be covered in this course. This course studies the fundamentals of how the design and operation of internal combustion engines affect their performance, efficiency, fuel requirements, and environmental impact.

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

**[ME 1606.1]** Describe an over view of IC engine, their classification, application and interpret performance parameter characteristics.

**[ME 1606.2]** Improve and optimize future engine designs for specific sets of constraints (fuel economy, performance, emissions).

**[ME 1606.3]** Distinguish different properties of non-petroleum fuels to find suitability of it for IC engine application and availability of these alternative fuels for employability in automobiles sector.

**[ME 1606.4]** Rephrase different electronic fuel injection system, supercharging and its effect on performance of SI and CI engine.

**[ME 1606.5]** Interpret the real-world engine design issues and solutions.

## 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.

**PROGRAM SPECIFIC OUTCOMES:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | Quizzes (Open Book/Close Book) and Assignments | 30 |
| 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/ (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

History of IC engines, Nomenclature, Classification, Comparison. Actual cycles. Testing & Performance, Emission Measurement, Conventional Fuels, Additives. Introduction of Alternative Fuels: Preparation, Engine performance, Combustion in CI & SI engines, Ignition Limits, Stages of combustion, Combustion parameters. Delay period and Ignition Lag, Turbulence and Swirl, Detonation & knocking, Theories of detonation. Combustion chamber. Engine Systems & Components: Fuel System, Injection systems, Ignition system, engine Friction & Lubrication, engine cooling. Supercharging & Turbocharging. Scavenging, Dual & Multi fuel engines: Principle, fuels, Combustion, performance Advantages, Modification in fuel system. Special Engines: Working principles of Rotary, Stratified charge, Free piston, Variable compression ratio engines.

## F. BOOKS

**Text Books:**

T1. J. B. Heywood, Introduction to Internal Combustion Engines, McGraw Hill Publication, 2011.

T2. V. Ganesan, Internal Combustion Engine, McGraw Hill Publication, 4th Edition, 2012.

**Reference Books:**

R1. C. Ferguson, Internal Combustion Engines, John Wiley & Sons, 2nd Edition, 2016.

R2. R. Stone, Introduction to Internal Combustion Engines, The McMillan Press, 4th Edition, 2012.

R3. Edward Obert F., Internal Combustion Engines, Harper and Raw Publisher.

## 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 | | Lecture<br><br>Interaction | - | NA |
| **2** | History of IC engines | Recall about basic thermodynamics and discuss about continuous development in the field of engines | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.1 | In Class Quiz (Not Accounted) |
| **3,4** | Nomenclature, Classification | Organize and identify the components of engines, Detail study of reciprocating engines | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.1 | Class Quiz/ Home Assignment/ Mid Term I/End Term |
| **5,6,7** | Comparison. Actual cycles | Discuss and recall the basic air standard cycles of thermodynamics | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.1 | |

| | | | | | |
|---|---|---|---|---|---|
| **8,9** | Engine Systems & Components: Fuel System, | Distinguish between carburetion and injection | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.4 | |
| **10,11,12** | Injection systems, Ignition system | Discuss about the advanced injection systems, Compare different ignition systems | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.4 | Class Quiz/ Home Assignment /Mid Term II/End Term |
| **13,14,15** | Engine Friction & Lubrication | Discuss the friction in parts of engine and suitable lubricating principle, Distinguish the different lubrication systems | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.4 | |
| **16,17** | Engine cooling. | Identify and discuss the components of cooling system | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.4 | |
| **18** | Combustion in CI & SI engines | Combustion phenomena, Essential requirement for combustion process, Explain pre mixed and diffussion combustion | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.2 | |
| **19,20,21** | Ignition Limits, Stages of combustion, Combustion parameters. | Identify the different stages of combustion and their impact of engine parameters | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.2 | Class Quiz/ Home Assignment /Mid Term II/End Term |
| **22,23,24** | Delay period and Ignition Lag, Turbulence and Swirl | Effect of ignition lag and delay period on combustion, Turbulence and swirl. | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.2 | |
| **25,26,27** | Detonation & knocking, Theories of detonation. | The effects of abnormal combustion | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.5 | |

| | | | | | |
|---|---|---|---|---|---|
| **28,29** | Combustion chamber | Identify the variables through which control of abnormal combustion is possible, also design the chamber according to that | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.5 | Class Quiz/ Home Assignment/End Term |
| | | | | | |
| **30,31,32 ,33,34** | Testing & Performance, Emission Measurement | Compute the performance parameters, their analysis and interpretation, Discuss about tail pipe emissions measurement and standards | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.2 | |
| **35,36** | Conventional Fuels, Additives | Essential properties of IC engine fuels, Analyse the petroleum extraction and refining process with structure analysis, impact of additives | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.3 | |
| **37,38** | Introduction of Alternative Fuels: Preparation, Engine performance | Identify the need of alternative fuels, Suitability of different types of alternative fuels for use in IC engine | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.3 | Class Quiz/ Home Assignment/End Term |
| **39,40** | Supercharging & Turbocharging. Scavenging, | Design and analyse the additional system for improving the performance of engine | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.5 | |
| **41,42** | Dual & Multi fuel engines: Principle, fuels, Combustion, performance Advantages | Compare the dual fuel, multi fuel and hybrid engines | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.4 | Class Quiz/ Home Assignment/End Term |
| **43** | Modification in fuel system. | Engine modification for dual fuel | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.5 | Class Quiz/ Home Assignment/End Term |
| **44** | Special Engines: | Discuss the development in I C engines | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.5 | Class Quiz/ Home Assignment/End Term |

| | | | | | |
|---|---|---|---|---|---|
| **45,46** | Working principles of Rotary | Discuss the development in I C engines | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.5 | Class Quiz/ Home Assignment/End Term |
| **47** | Stratified charge, | Discuss the development in I C engines | Lecture/ PPT/ Discussion & Question Answer | ME 1606.5 | Class Quiz/ Home Assignment/End Term |
| | | | Session | | |
| **48,49** | Free piston, Variable compression ratio engines. | Design principal of advanced variable compression engine | Lecture/ PPT/ Discussion & Question Answer Session | ME 1606.5 | Class Quiz/ Home Assignment/End Term |
| **50** | Conclusion and Course Summarization | Overall revision of the course | Discussion & Question Answer Session | | |

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

| CO | STATEMENT | Correlation with Program Outcomes **(POs)** | | | | | | | | | | | | Correlation with Program Specific Outcomes **(PSOs)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
| **[ ME1606.1 ]** | Describe an over view of IC engine, their classification, application and interpret performance parameter characteristics. | **3** | **2** | **2** | | | | **1** | | | | | **1** | | | |
| **[ ME1606.2 ]** | Improve and optimize future engine designs for specific sets of constraints (fuel economy, performance, emissions). | | **1** | **3** | | | | | | **1** | | | | | **1** | |
| **[ ME1606.3 ]** | Distinguish different properties of non-petroleum fuels to find suitability of it for IC engine application and availability of these alternative fuels for employability in automobiles sector. | | | | | | | **2** | | | | | | | **3** | |
| **[ ME1606.4 ]** | Rephrase different electronic fuel injection system, supercharging and its effect on performance of SI and CI engine. | | | **2** | | **1** | | | | | | | | | **1** | |
| **[ ME1606.5 ]** | Interpret the real-world engine design issues and solutions. | | **1** | **3** | | | | **1** | | | | | | | **1** | |

**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
Metrology | ME 1607 | 3 Credits | 3 0 0 3
Session: Jan'21 – May'21 | Faculty: Mr Anurag Joshi, Mr G S S Adithya & Dr R K Gupta |
**Class: B.Tech VIth Semester**

**A. Introduction**: This course is offered by Dept. of Mechanical Engineering for 6th Semester students, targeting students who wish to pursue research & development in industries or higher studies in field of Metrology, including study of various aspects of measuring instruments. Offers in-depth knowledge in Fits & gauges as well as various techniques by which the topography of a surface can be studied. Students are expected to have a background knowledge on basic measuring instruments for better learn.

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

**[ME 1607.1]** Identify the different measuring systems and standards employed in industry.

**[ME 1607.2]** Describe and differentiate various form errors on surface various mechanical components in industry.

**[ME 1607.3]** Identify the different types of fits of a several mating parts of an industrial component for skill improvement.

**[ME 1607.4]** Distinguish between various measurements instruments employed in a manufacturing industry.

**[ME 1607.5]** Describe and distinguish between various parameters of errors involved in threads and gears for skill development.

## 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.

## Program Specific Outcomes:

**[PSO.1]. Model and analyse of Mechanical Engineering systems and components.**
**[PSO.2]. Design and performance evaluation of energy systems.**
**[PSO.3]. Testing of materials and analysis of manufacturing processes for mechanical engineering applications.**

**D. Assessment Plan:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | | |
| | Sessional Exam II (Close Book) | 15 |
| | | |
| | In class Quizzes, Presentations and Assignments, Activity feedbacks (Accumulated and Averaged) | 30 |
| | | |
| 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 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:**

Measurements & Measurement Systems: Measuring Standards. Static Characteristics of Instruments & measurement systems, Measurement of Pressure, Temperature, strain, force, torque and Shaft work. Limits, Fits and Tolerances: Interference and Transition fits, System of fits, Hole basis and Shaft basis. Gauges: Types of gauges & design. Measurement of Form Errors: Flatness, straightness and squareness measurement, Engineer's Square tester, Optical Square. Comparators, Principles, construction & working of mechanical & optical comparators. Screw Threads: Design principle and application. Surface Texture measurement: Methods of measurement, Principles of design and operation. Gear measurement: Gear terminology, Errors in gears, Composite Tooth thickness, Gear tooth Vernier Callipers, Constant chord method, Base tangent method, Geometric Dimension & Tolerances.

**F. Text Books:**

1. A.K. Bewoor & V. Kulkarni, Metrology & Measurement, McGraw Hill Publication, 2012.

**G. References:**

1. N.V. Raghavendra & L. Krishnamurty, *Engineering Metrology & Measurements*, Oxford Publications, 2013
2. Thomas G. Beckwith, John H. Lienhard V, Roy D. Marangoni, Mechanical Measurements, Sixth Edition, Pearson Prentice Hall 2007.

## H. Lecture Plan: Metrology (ME 1607)

| Lecture Number | Topic to be covered | Mode of delivery | Session Outcomes | Corresponding CO | Mode of assessing the outcome |
|---|---|---|---|---|---|
| L1 | Introduction to Metrology | Chalk-Talk/PPT | Why Metrology and the importance of Mechanical Measurement | NA | NA |
| L2 | Methods of measurement and errors in measurement | Chalk-Talk/PPT | Will be able to recall and reconceptualise of various method of measurement according to the standards | 1607.1/ 1607.2 | Quiz/ Test/ Assignment |
| L3 | Generalized Measurement System & its elements | Chalk-Talk/PPT | Categorize the measurement systems | 1607.1 | Quiz/ Test/ Assignment |
| L4 | Static Characteristics of Instruments & measurement systems | Chalk-Talk/PPT | Recall the measurement systems and associated properties | 1607.2 | Quiz/ Test/ Assignment |
| L5–L6 | Measurement of Pressure | Chalk-Talk/PPT | Discuss the instruments used for measurement of pressure | 1607.2 | Quiz/ Test/ Assignment |
| L7–L8 | Measurement of Temperature | Chalk-Talk/PPT | Discuss the instruments used for measurement of Temperature | 1607.2 | Quiz/ Test/ Assignment |
| L9 – L10 | Measurement of Strain | Chalk-Talk/PPT | Discuss the instruments used for measurement of Strain | 1607.2 | Quiz/ Test/ Assignment |
| L11 – L12 | Measurement of Force, Torque & Shaft Power | Chalk-Talk/PPT | Discuss the instruments used for measurement of Temperature | 1607.2 | Quiz/ Test/ Assignment |
| L13 | Introduction to Limits, Fits and Tolerances | Chalk-Talk/PPT | Understand the use of fits and assembly | 1607.3 | Quiz/ Test/ Assignment |
| L14 | Grades of Tolerance | Chalk-Talk/PPT | Understand and deliver the types of tolerances | 1607.3 | Quiz/Test/Assignment |
| L15 | Types of fit & Hole basis and Shaft basis | Chalk-Talk/PPT | Understand and application of HBS and SBS | 1607.3 | Quiz/Test |

| | | | | | |
|---|---|---|---|---|---|
| L16-L19 | Gauges: Types of gauges, construction, | Chalk-Talk/PPT | Will be able to understand and design the gauges | 1607.3 | Quiz/ Test/ Assignment |
| | design and application | | | | |
| L20 – L22 | Flatness measurement, straightness and Squareness measurement, Autocollimeter | Chalk-Talk | Describe the working and use of instruments | 1607.4 | Quiz/ Test/ Assignment |
| L23 – L25 | Indicator method, Engineer's Square tester, Optical Square, Simple numericals on Straightness | Chalk-Talk | Describe the working and use of instrument | 1607.4 | Quiz/ Test/ Assignment |
| L26 | Comparators: Introduction & types | Chalk-Talk/PPT | Describe the working and use of instruments | 1607.4 | Quiz/ Test/ Assignment |
| L27 – L28 | Mechanical Comparators | Chalk-Talk/PPT | Describe the working and use of instruments | 1607.4 | Quiz/ Test/ Assignment |
| L29 – L30 | Optical Comprators | Chalk-Talk | Describe the working and use of instruments | 1607.4 | Quiz/ Test/ Assignment |
| L31-L32 | types of screw threads, principles of design and application | Chalk-Talk/PPT | Describe the working and use of instruments | 1607.4 | Quiz/ Test/ Assignment |
| L33- L36 | Surface Texture measurement, Methods of measurement, Principles of design and operation | Chalk-Talk/PPT | Will be able to know the instrument used for measurement of roughness value – Theoretically and Practically | 1607.4 | Quiz/Test/ Assignment/ Demonstration |
| L37 – L38 | Errors in gears, Composite Tooth thickness, Gear tooth Verneir callipers, | Chalk-Talk/PPT | Discuss the features associated with gear measurement | 1607.5 | Quiz/ Test/ Assignment |

| 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 |
| **[ME 1607.1]** | Identify the different measuring systems and standards employed in industry. | 3 | 2 | 1 | 1 | 1 | | | | | | | | 1 | | 1 |
| **[ME 1607.2]** | Describe and differentiate various form errors on surface various mechanical components in industry. | 3 | 1 | 2 | 1 | 1 | | | | | | | | | | 1 |
| **[ME 1607.3]** | Identify the different types of fits of a several mating parts of an industrial component for skill improvement. | 2 | 2 | 1 | 1 | 2 | | | | | | | | | | 2 |
| **[ME 1607.4]** | Distinguish between various measurements instruments employed in a manufacturing industry. | 3 | 2 | 2 | 2 | 1 | 2 | 1 | | | | | | 1 | | 1 |
| **[ME1607.5]** | Describe and distinguish between various parameters of errors involved in threads and gears for skill development. | 3 | 2 | 2 | 2 | 1 | | | | | | | | | 1 | |

**MANIAPL UNIVERSITY JAIPUR**
School of Automobile, Mechanical and Mechatronics

**DEPARTMENT OF MECHANICAL ENGINEERING**

Course Hand-out

Internal Combustion Engine Lab| ME1633 | 1 Credits 0 0 2 1

Session: Odd Semester 2020-21 | Faculty: Mr. Hemant Raj Singh/Mr. Arpit Khandelwal/Mr. Sumit Taneja/Dr. Rahul Goyal/Dr. Abhishek Sharma/ Dr. Saurabh Dewangan | Class: B.Tech VI Sem

A. **Introduction:** This course is offered by Dept. of Mechanical Engineering, targeting students who wish to pursue research& development in automobile industries or higher studies in field of Mechanical engineering. This course studies the fundamentals of how the design and operation of internal combustion engines affect their performance, efficiency, fuel requirements, and environmental impact.

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

**[ME1633.1].** Understand the importance of IC engine as a prime mover and compare its performance on the basis of thermodynamic cycles.
**[ME1633.2].** Identify the various components of IC engines and assemble and dissemble the parts.
**[ME1633.3].** Evaluate the performance of IC engines and evaluate various performance parameters and gain knowledge about the various factors affecting these parameters.
**[ME1633.4].** Estimate the heat balance sheet of an IC engine that how heat energy available in engine cylinder is utilized.
**[ME1633.5].** To understand the working of reciprocating air compressor and apply the basic laws of thermodynamics to find solutions to engineering problems regarding the devices

## 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.

**Programme Specific Outcomes:**

**[[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Lab work and Assignments | 60 % |
| End Term Exam (Summative) | End semester examination | 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

Cut Sectional 4 Stroke 1 Cylinder Petrol Engine for valve timing diagram; 4 stroke 4 cylinder Diesel engine test rig with Electrical dynamometer; Evaluating friction by morse test on multi cylinder test rig; Four Stroke Four Cylinder Petrol Engine Test Rig With Electrical Dynamometer; Performance Test of 4 stroke 3 cylinder Petrol engine test rig with (AC dynamometer) with heat balance sheet; To Determination The Compression Ratio of Computerised CI Engine; Performance test of two stroke SI Engine (Single cylinder) with AC generator; Performance test of four stroke single cylinder CI engines test rig with DC generator; Performance test of four stroke single cylinder CI engines test rig with rope brake dynamometer; Performance test of four stroke single cylinder CI engines test rig with hydraulic dynamometer

## F. Text Books:

1. S. Domukundwar, C.P. Kothandaraman, A course in Thermal Engineering, Dhanpath Rai, 2002.

## G. References:

1. P.L. Ballaney, Internal Combustion Engines, Khanna Publication, 2007.

## H. Lecture Plan:

| Lab No | **Name of the Experiment** | **Type of Expt** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| L1 | Study of cut sectional four stroke single cylinder petrol engine for valve timing diagram | Hands on | CO1 and CO2 | Observational Data, Viva-Voce |
| L2, | Performance test on four stroke single cylinder diesel engine test rig with hydraulic dynamometer | Hands on | CO1 and CO3 | Observational Data, Viva-Voce |
| L3 | Performance test on four stroke single cylinder diesel engine test rig with dc generator | Hands on | CO1 and CO3 | Observational Data, Viva-Voce |
| L4 | Performance test on four stroke single cylinder diesel engine test rig with brake drum | Hands on | CO1 and CO3 | Observational Data, Viva-Voce |
| L5 | Heat balance sheet for four stroke single cylinder diesel engine test rig with hydraulic dynamometer | Hands on | CO3 and CO4 | Observational Data, Viva-Voce |
| L6 | Heat balance sheet for four stroke single cylinder diesel engine test rig with dc generator | Hands on | CO3 and CO4 | Observational Data, Viva-Voce |
| L7 | Heat balance sheet for four stroke single cylinder diesel engine test rig with brake drum | Hands on | CO3 and CO4 | Observational Data, Viva-Voce |
| L8 | Evaluating friction morse test on multi-cylinder test rig- four stroke four-cylinder petrol engine test rig with hydraulic dynamometer | Hands on | CO3 and CO4 | Observational Data, Viva-Voce |
| L9 | Performance test: four stroke 3 cylinder petrol engine test rig with (ac dynamometer) with heat balance sheet | Hands on | CO3 and CO4 | Observational Data, Viva-Voce |

| | | | | |
|---|---|---|---|---|
| L10 | TO DETERMINE THE ISOTHERMAL EFFICIENCY OF TWO STAGE RECIPROCATING AIR COMPRESSOR | Hands on | CO5 | Observational Data, Viva-Voce |

## I. 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 |
| [ME1633.1] | Understand the importance of IC engine as a prime mover and compare its performance on the basis of thermodynamic cycles | 3 | 2 | | | | | | | | | | | | 1 | |
| [ME1633.2] | Identify the various components of IC engines and assemble and dissemble the parts. | 3 | | 1 | | | | | | | | | | | 1 | |
| [ME1633.3] | Evaluate the performance of IC engines and evaluate various performance parameters and gain knowledge about the various factors affecting these parameters. | | 3 | | | | | 2 | | | | | 2 | | 3 | |
| [ME1633.4] | Estimate the heat balance sheet of an IC engine that how heat energy available in engine cylinder is utilized. | 2 | | | 2 | | | | | | | | 2 | | 1 | |
| [ME1633.5] | To understand the working of reciprocating air compressor and apply the basic laws of thermodynamics to find solutions to engineering problems regarding the devices | 3 | | 2 | | | | | | | | | | | | |

Optimization Techniques | ME 1653 | 3 Credits | 3 0 0 3

Session: Jan – June 21 | Faculty: Vijay Shankar Kumawat | Class: VIth Semester

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering as an Open Elective, targeting students who wish to pursue research& development in industries or higher studies in field of Manufacturing Engineering, Industrial Engineering, and Operations Management, and Material Handling. Offers in depth knowledge Optimization Techniques strategy by covering Linear Programming Problems, Transportation Problems, Job/ Machine Assignment Problems, Job/Machine Sequencing & Scheduling Problems, Project Management Problems and gives an introductory level knowledge on decision making at every level in product process and assembly line Students are expected to have background knowledge on industrial problems and mathematical formulation for a better learning.

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

**[ME 1653.1]** The aim is to explain the concepts to understanding problem solving methods for effective decision making.

**[ME 1653.2]** To identify situations in which LPP technique can be applied.

**[ME 1653.3]** Students can able to learn & formulate a transportation problem involving large number of shipping routes. Also, Profit maximization in transportation problems & production job activities

**[ME 1653.4]** To understand how optimal strategies are formulated in conflict and competitive environment like product mix problems, line balancing problem.

**[ME 1653.5]** To understand the significance of using PERT and CPM techniques for project management. Also, Students can able to determine the probability of completing a project on or before the schedule date.

## 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.

**Programme Specific Outcomes:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Open Book) | 15 |
| | Sessional Exam II (Open Book) | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open 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

**Introduction:** Definition, phases, applications, advantages and disadvantages of Operations Research. Allocation Models**.**

**Linear Programing Problem (LPP):** Formulation of LPP, Graphical solution of LPP, Simplex method, Big M, Two phase method.

**Transportation Problem:** Initial Basic Feasible Solution algorithms for transportation problems using North-West Corner (NWC) Method, Least Cost (LC) Method, Vogel's Approximation Method (VAM), finding optimal solution by Modified Distribution (MODI) Method, Maximization and Unbalanced problems.

**Assignment Problem:** Solution algorithm for Assignment Problem, Maximization and Unbalanced problems, Application problems, travelling salesman problems.

**Sequencing problem:** Johnson's Solution algorithm for job sequencing problem: n jobsX 2 machine problem, n jobs X 3 machine problem, n jobs X m machine problem

**Network Models:** Critical Path Method (CPM): Introduction to network analysis, critical path, determination of project duration, earliest start time, earliest finish time, latest start time, latest finish time Project Evaluation and Review Technique (PERT): critical path for uncertain project, determination of project duration, Project Crashing. **Game Theory:** Introduction to game theory, Saddle point, Dominance, Two-person-zero sum games, (2 x n games; m x 2 games)

**Inventory Management:** EOQ, ABC analysis, MRP.

## F. TEXT BOOKS


1. P.K.Gupta and Hira, Operations Research, Sultan Chand and Sons, 2003
2. H. A.Taha, Operations Research, Pearson Education, 7Th Edition, 2002.


## G. REFERENCE BOOKS


1. Paul Loomba, Management, A Quantitative Perspective, MacMillan, New York, 1978.
2. D. Sharma, Operations Research, Kedar Nath Ramnath Publications, 14th Edition, 2005

## H. Lecture Plan:

| Lecture | Topic | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| L-1 | Linear Programming – Terminology and formulations<br>• Operations research: Definition, Approach to problem solving, Advantages, Opportunities<br>• Terminology & limitations<br>• LP formulation through an example | Students will learn concept and importance of optimization techniques. | Lecture/PPT | **[1653.1]** | NA |
| L-2 | Linear Programming Formulation:<br>• Type 1: Product mix problems with example<br>• Type 2: Production planning problems with example | Linear Programming Formulation | Lecture/PPT | **[1653.1]** | Mid-Term 1 /End-Term |
| L-3 | Linear Programming Formulation:<br>• Type 3: Inventory control problems with example | Linear Programming Formulation | Lecture/PPT | **[1653.3]** | Mid-Term 1 |
| L-4 | Linear Programming Problems/ Solutions<br>• Algebraic method with examples<br>• Graphical Method with examples | Linear Programming Problems/ Solutions | Lecture/PPT | | |
| L-5 | Linear Programming Problems/ Solutions<br>• Simplex method with examples<br>• Maximization & Minimization problems | Linear Programming Problems/ Solutions | Coursera/Lecture/PPT | **[1653.2]** | Mid-Term 1 |
| L-6 | Linear Programming Problems/ Solutions<br>• Big-M method with examples<br>• Maximization & Minimization problems | | Lecture/PPT | | |

| | | | | | |
|---|---|---|---|---|---|
| L-7 | Linear Programming Problems/ Solutions | Linear Programming | Coursera/Lecture/PPT | **[1653.2]** | Mid-Term 1 Quiz |
| | • Two-phase method with examples<br>• Maximization & Minimization problems | Problems/ Solutions | | | |
| L-8 | Linear Programming Problems/ Solutions<br>• Bounded solution<br>• Unbounded solution<br>• Cyclic solution<br>• Infeasible solution | | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 1 /End-Term |
| L-9 | Transportation Problem<br>• Introduction<br>• Concept & terminology<br>• Feasible solution<br>• Infeasible solution<br>• Initial Basic feasible solution<br>• Optimal solution | Transportation Problem | Lecture/PPT | | |
| L-10 | Initial basic feasible solution<br>• North West Corner Method<br>• Example with balanced and unbalanced problem | Transportation Problem And IBFS | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 1 /End-Term |
| L-11 | Initial basic feasible solution<br>• Least Cost Method<br>• Example with balanced and unbalanced problem | IBFS | Lecture/PPT | **[1653.3]** | Mid-Term 1 /End-Term |
| L-12 | Initial basic feasible solution<br>• Vogel's Approximation Method<br>• Example with balanced and unbalanced problem | IBFS | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 1 /End-Term |
| L-13 | Optimum solution for transportation problems<br>• Stepping stone method with example | Optimality in transportation | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 1 /End-Term |

| | | | | | |
|---|---|---|---|---|---|
| L-14 | Optimum solution for transportation problems<br>• MODI method with example | Optimality in transportation | Lecture/PPT | **[1653.3]** | Mid-Term 1 |
| L-15 | Tutorial-1 | | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 1 Quiz |
| L-16 | Tutorial-2 | | Lecture/PPT | **[1653.3]** | Mid-Term 1 /End-Term |
| | | | | | |
| L-17 | Assignment Problems<br>• Introduction<br>• Concept & terminology<br>• Rules of Hungarian algorithm | Assignment Problems | Lecture/PPT | **[1653.3]** | |
| L-18 | Assignment Problems<br>• Example with balanced and unbalanced problem | Hungarian Method | Lecture/PPT | **[1653.3]** | Lecture/PPT |
| L-19 | Assignment Problems<br>• Travelling Salesmen Problems with balanced and unbalanced examples | Assignment Problems | Lecture/PPT | | Mid-Term 1 /End-Term |
| L-20 | Sequencing Problems<br>• Introduction<br>• Concept & terminology<br>• Rules of Jhonson's algorithm<br>• N Jobs X 2 Machines Problems with elapsed time & idle time of each machine | Sequencing Problems | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 2//End-Term |
| L-21 | Sequencing Problems<br>• N Jobs X 3 Machines Problems elapsed time & idle time of each machine | Sequencing Problems | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 2//End-Term |
| L-22 | Sequencing Problems<br>• N Jobs X M Machines Problems elapsed time & idle time of each machine | | Lecture/PPT | **[1653.3]** | Mid-Term 2//End-Term |
| L-23 | Tutorial-3 | | | | Mid-Term 2//End-Term |
| L-24 | Tutorial-4 | | Lecture/PPT | **[1653.3]** | |

| | | | | | |
|---|---|---|---|---|---|
| L-25 | Critical Path Method (CPM)<br>• Introduction to network analysis,<br>• critical path of project<br>• activities, events<br>• procedure to draw network diagram | network analysis | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 2 |
| L-26 | Critical Path Method (CPM)<br>• determination of project duration, | network analysis | Lecture/PPT | **[1653.3]** | Mid-Term 2//End-Term |
| | • earliest start time<br>• earliest finish time<br>• latest start time<br>• latest finish time<br>• float | | | | |
| L-27 | Project Evaluation and Review Technique (PERT)<br>• Difference between CPM & PERT<br>• uncertain project activities<br>• determination of project duration | network analysis | Lecture/PPT | **[1653.3]** | Assignment & Discussion |
| L-28 | Game Theory<br>• Introduction to game theory, Saddle point, Dominance, | Game Theory | Lecture/PPT | **[1653.3]** | Mid-Term 2//End-Term |
| L-29 | Game Theory<br>• Two-person-zero sum games, (2 x n games; m x 2 games) | Game Theory | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 2//End-Term |
| L-30 | Inventory Management<br>• EOQ model | Inventory management and heir optimization | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 2 |
| L-31 | Inventory Management<br>• ABC analysis<br>• MRP. | Material handling and planning | Coursera/Lecture/PPT | **[1653.3]** | Mid-Term 2//End-Term |
| L-32 | Tutorial-5 | | Lecture | **[1653.3]** | Assignment & Discussion |
| L-33 | Tutorial-6 | | Lecture | **[1653.3]** | Mid-Term 2 |

| | | | | | |
|---|---|---|---|---|---|
| L-34 | Revision of course | | Lecture | **[1653.3]** | Mid-Term 2 |
| | | | Coursera/Lecture/PPT | **[1653.4]** | Mid-Term 2//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 |
| **ME 1653.1** | The aim is to explain the concepts to understanding problem solving methods for effective decision making. | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| **ME 1653.2** | To identify situations in which LPP technique can be applied. | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 |
| **ME 1653.3** | Students can able to learn & formulate a transportation problem involving large number of shipping routes. Also, Profit maximization in transportation problems & production job activities | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| **ME 1653.4** | To understand how optimal strategies are formulated in conflict and competitive environment like product mix problems, line balancing problem. | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **ME 1653.5** | To understand the significance of using PERT and CPM techniques for project management. Also, Students can able to determine the probability of completing a project on or before the schedule date. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 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: 35%** | | | | | | | | | | | 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 |
| **ME 1653.1** | The aim is to explain the concepts to understanding problem solving methods for effective decision making. | 3 | | | | | | | | | | | 1 | | 2 | |
| **ME 1653.2** | To identify situations in which LPP technique can be applied. | 3 | 2 | 2 | | | | | 2 | | | | 1 | | 2 | |
| **ME 1653.3** | Students can able to learn & formulate a transportation problem involving large number of shipping routes. Also, Profit maximization in transportation problems & production job activities | | | | 3 | | | | | | 2 | | 1 | | 2 | |
| **ME 1653.4** | To understand how optimal strategies are formulated in conflict and competitive environment like product mix problems, line balancing problem. | 2 | | 1.33 | | | 1.33 | | | | | | 0.67 | | 1.33 | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ME 1653.5** | To understand the significance of using PERT and CPM techniques for project management. Also, Students can able to determine the probability of completing a project on or before the schedule date. | 3 | 2 | 2 | 3 | | 2 | 2 | | | 2 | | 1 | | 2 | |

**0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment**

# MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

Tool Engineering| ME 1655| 3 Credits | 3 0 0 3

Session: Jan 2021 – May 2021 | Faculty: Dr. Anand Pandey | Class: VI Semester (B.Tech)

**A. Introduction**: This course is offered by Dept. of Mechanical Engineering for 6th Semester B Tech Mechanical Engineering students, who wish to pursue specialization course or higher studies in the field of Machining & design/manufacturing of cutting tools or research & development in industries. It offers in depth knowledge of technical skills required by our students to become leaders in the field of production and operations management and related professions. This course provides the Machining viz. designing of cutting tools. It deals with industrial application of automotive and high strength alloys using tools.

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

**[ME 1655.1].** Recognize the concepts and applications of tools materials & their geometry.

**[ME 1655.2].** U n d e r s t a n d t h e Design-tool geometry of single and multiple point cutting tools in Machining.

**[ME 1655.3].** To acquire and design the Tools based on operations for skill enhancement and employability.

**[ME 1655.4].** Design and remember the various cutting tool and work holding devices.

**[ME 1655.5]** Distinguish types of work holding devices.

**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.

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**C. Assessment Plan:**

| Criteria | Description | Ma |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)<br>Quiz: Q1 on 01 Feb 2019<br>Q2 on 02 March 2019<br>Q3 on 07April 2019 | 30 ( Assignment and quiz carries 05 Marks |

| | | |
|---|---|---|
| | Assignment: Two (2) Assignments to each students based on experimental study using cutting | each) each) |
| | A2 on 25 Feb 2019 ( 08 Mar 19)<br>A3 on 25 Mar 2018 (08 Apr 19) | |
| 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. | |

## E. Syllabus:

**Fundamental of Tool design practice, procedure of tool design, Design of single point cutting tools such as solid tools , tipped tools, coated tipped tools, throw away type tools and diamond tools; design of milling cutters, gear milling cutters, hobs gear shaping tools, broaches, drills, reamers, taps & dies for thread cutting, boring tools, flat form tools, circular form tools. Essential requirements of jigs & fixtures, economics of jigs and fixtures, principles of location and clamping, location and clamping devices, types of drill bushes, types of jigs and fixtures- such as fixtures for milling, welding, heat treatment, grinding, assembly and inspection processes; standardization in jigs and fixtures, principle of work holders, common work holders for production like vice, chuck, arbor, mandrel & collet.**

## F. Text Books:


1. C. Donaldson, G.H. Lecain, V.C. Goold, Tool Design, McGraw Hill Publication, 4th Edition 2013.
2. N.K.Mehta, Metal Cutting and Design of Cutting Tools, Jigs & Fixtures. McGraw Hill Publication, 2015.


## G. References:

1. A.B. Chattopadhyay, Machining and Machine Tools, John Wiley Publication, 2015

## H. Lecture Plan: Tool Engineering: (ME 1655)

| Lec No | Topics | Session Outcome | Mode of Delivery | Corresponding CO | Mode of |
|---|---|---|---|---|---|
| L1-2 | Objectives and scope of Tool Engineering | Recall the objectives and applications of Tool Materials Management. | Lecture/Black Board | ME 1655.1 | In Class Quiz ( Not Accounted) |
| L3-4 | Fundamental of Tool design practice | Recall the utility and importance of tools design | Lecture/Black board | ME 1655.1 | In Class Quiz End Term |
| L5 | Procedure of tool design, Design of single point cutting | Describe the tool geometry of single point cutting tool (Angles), applications and its manufacturing | Lecture/ppt | ME 1655.2 | Home Assignment End Term |
| L6-7 | Design concepts of solid tools, tipped tools, coated tipped tools, | Describe the detailed tool geometry and functions of solid tools, coated and tipped tools | Lecture/ppt | ME 1655.2 | In Class Quiz End Term |
| L8-9 | Design concepts of throw away type tools and diamond tools. | To learn the design and development of tools. | Lecture/ppt | ME 1655.2 | Class Quiz Mid Term I End Term |
| L10-12 | Design of milling cutters, gear milling cutters, hobs gear shaping | To design and learn the tool geometry of milling cutting tools. | Lecture/ppt | ME 1655.2 | Class Quiz Mid Term I End term |

| | | | | | |
|---|---|---|---|---|---|
| L13 | Types of broaches & design concepts | To learn the application and tool geometry of broaches. | Lecture/ppt | ME 1655.2 | Home Assignment Class Quiz Mid |
| L14-15 | Types of Drills & tool geometry | To learn the types of drills | Lecture/ppt | ME 1655.2 | Class Quiz Mid Term |
| L16-17 | Types of Reamers & tool geometry | Be able to understand the fundamentals of reamers | Lecture/ppt | ME 1655.3 | Class Quiz Mid Term II End |
| L18-19 | Types of taps & dies for thread cutting | To acquire the skills and knowledge of taps and dies | Lecture/ppt | ME 1655.3 | Class Quiz End Term |
| L20-21 | Types of boring tools and its design geometry | To know the about the boring applications and its design concepts. | Lecture/ppt | ME 1655.3 | Class Quiz Mid Term II End Term |
| L22-23 | Design-geometry of flat form tools, circular form tools. | To learn the technical details of form tools. | Lecture/ppt | ME 1655.3 | Class Quiz |
| L24-25 | Essential requirements of jigs & fixtures | To learn the concepts of design, setting and measuring datum surfaces. | Lecture/ppt | ME 1655.4 | Mid Term II End Term |
| L26-27 | Locating scheme, error analysis and elements of prismatic parts | To understand the designing concepts of Jigs and fixture. | Lecture/ppt | ME 1655.4 | Class Quiz |

| | | | | | |
|---|---|---|---|---|---|
| L28-29 | Economics of jigs and fixtures | To understand the economics of Jigs & fixture in Manufacturing | Lecture/ppt | ME 1655.4 | Mid Term II<br>End Term |
| L30-31 | Principles of location and clamping | To know the fundamentals of clamping principles, method and elements | Lecture/ppt | ME 1655.4 | Class Quiz |
| L32-33 | Types of drill bushes. | To learn the types of drill bushes and their tool geometry. | Lecture/ppt | ME 1655.4 | Mid Term II<br>End Term |
| L34-35 | Types of jigs and fixtures- such as fixtures for milling, welding, heat treatment, grinding, assembly and inspection processes; | To understand the basics, geometry, applications of types of jigs and fixtures. | Lecture/ppt | ME 1655.5 | End Term |
| L36 | Standardization in jigs and fixtures, | To acquire the concepts of Jigs for standardization | Lecture/ppt | ME 1655.5 | End Term |

| | | | | | |
|---|---|---|---|---|---|
| L37-39 | Principle of work holders, common work holders for production like vice, chuck, arbor, mandrel & collet. | To understand the concepts of design related to work holding devices. | Lecture/ppt | ME 1655.5 | End Term |

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

| CO | STATEMENT | CORRELATION WITH PROGRAM OUTCOMES | | | | | | | | | | | | CORRELATION WITH PROGRAM SPECIFIC | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO - 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PS | PSO | PSO 3 |
| **[ME 1655.1]** | Understand the concepts, scope and applications of tools materials & their geometry. | 1 | | | | | | | | | | | 1 | | | 2 |
| **[ME 1655.2]** | To learn the Design-tool geometry of single and multiple point cutting tools in Machining. | 2 | | | | | | | | | | | 1 | | | 2 |
| **[ME 1655.3]** | To acquire and design the Tools based on operations. | 1 | | | | | | | | | | | 1 | | | 2 |
| **[ME 1655.4]** | Design and learn the various cutting tool and work holding devices. | 1 | | | | | | | | | | | 1 | | | 1 |
| **[ME 1655.5]** | Different types of work holding devices. | 1 | | | | | | | | | | | 1 | | | 1 |

**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

**Alternative Fuels In I.C. Engines| ME 1656| 3 Credits | 3 0 0 3**

**Session: Jan 21-May 21 | Faculty: Dr. Abhishek Sharma| Class: B. Tech. (Mech.) 6th Semester**

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering for sixth semester students. This course offers knowledge in different kind of alternative fuels for automotive applications. Year by year reduction of crude level as well as increasing pollution level is alarming for automobile engineers. This course is a complete stuff of different alternative fuels and alternative energy sources. Students are expected to have background knowledge on basic IC Engine and properties of gasoline, diesel etc.

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

**[ME 1656.1]** Describe the effects of air pollution due to automotive vehicles, its effect on global warming and need of alternative fuels.
**[ME 1656.2]** Demonstrate engine modification required for the use of gaseous fuels like LPG, CNG, and Hydrogen etc.
**[ME 1656.3]** Distinguish different properties of non-petroleum fuels to find suitability of it for IC engine application and availability of these alternative fuels for employability in automobiles sector.
**[ME 1656.4]** Examine impact of alternative fuels on IC engine with respect to the formation of pollutants, engine performance and fuel efficiency.
**[ME 1656.5]** Evaluate importance of alternative fuel for IC engine, emission characteristic of alternative fuels and legalisation standard of usage of these fuels.

## 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.

**PROGRAM SPECIFIC OUTCOMES:**

**[PSO.1].** Model and analyse mechanical engineering components using advanced software.

**[PSO.2].** Analyse performance of I. C. engines attributed to alternate fuels.

**[PSO.3].** Synthesize advance materials for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | Quizzes (Open Book/Close Book) and Assignments | 30 |
| 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/ (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

Introduction: Need of alternative gaseous fuels, future automotive gaseous fuels, hydrogen, CNG, LNG, and Producer gas, biogas, LPG. Physical properties of different gaseous fuels, mode of engine operations, spark ignition and dual fuel mode, multi fuel mode, combustion and performance of engines, specific problems. Use of alcohol in four stroke S I & C I engines, use of alcohol in two stroke engines, use of bio diesels, combustion and performance of engines. Impact of alternative fuels on engine test, guidelines for emission measurements, emission norms for engines using alternative fuels. Legal aspects of blending alternative fuels into conventional liquid fuels, properties of blends, comparison of neat versus blended fuels, fuel testing.

**F. BOOKS**

**I. Text Books:**

1. J. B. Heywood, Introduction to Internal Combustion Engines, McGraw Hill Publication, 2011.
2. V. Ganeshan, Internal Combustion Engine, McGraw Hill Publication, 4th Edition, 2012.
3. S.S. Thipse "Alternative Fuels- Concepts, Technologies and Developments", Jaico Publishing House, 2010.

**II. Reference Books:**

1. C. Ferguson, Internal Combustion Engines, John Wiley Publication, 2nd Edition, 2016.
2. R. Stone, Introduction to Internal Combustion Engines, McMillan Press, 4th Edition, 2012.
3. R1. A.S. Ramadhas, "Alternative Fuels for Transportation", CRC Press, 2012.
4. G D Rai, Non-conventional Energy Sources, Khanna Publications, 1997.

**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 |
| 2,3 | Introduction: Need of alternative gaseous fuels | Identify the need of alternative fuels, Suitability of different types of alternative fuels for use in IC engine | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.1 | In Class Quiz (Not Accounted) |
| 4,5,6 | Future automotive gaseous fuels, hydrogen, CNG, LNG, and Producer gas, biogas, LPG. | Importance of gaseous fuels, comparison of different gaseous fuels and their merits and demerits | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.2 | Class Quiz/ Home Assignment/ Mid Term I/End Term |
| 7 | Physical properties of different gaseous fuels | Explore the properties of gaseous fuels, comparison of different gaseous alternative fuels and their merits and demerits | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.2 | |
| 8,9,10,11 | Mode of engine operations, spark ignition and dual fuel mode, multi fuel mode | Kind of modifications required to use gaseous fuels in IC engines | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.2 | |

| | | | | | |
|---|---|---|---|---|---|
| 12, 13, 14 | Combustion and performance of engines, specific problems. | Understand the combustion phenomena, identify the different stages of combustion and their impact on engine performance and emission | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.2 | Class Quiz/ Home Assignment /Mid Term II/End Term |
| 15,16, 17, 18 | Use of alcohol in four stroke S I & C I engines | Basic of alcohols and explore properties as engine fuel , | Lecture/ PPT/ | ME 1656.3 | |
| | | different kind of alcohols blends and their comparison | Discussion & Question Answer Session | | Class Quiz/ Home Assignment /Mid Term II/End Term |
| 19 | Use of alcohol in two stroke engines | Application of different kind of alcohols blends in two stroke engine | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.3 | |
| 20, 21 | Use of bio diesels | Basic of bio-diesel, production process of biodiesel, its properties, comparison of it with diesel | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.3 | Class Quiz/ Home Assignment/End Term |
| 22, 23 | Combustion and performance of engines | Effect of biodiesel on engine behaviour | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.3 | |
| 24,25, 26 | Impact of alternative fuels on engine | Analysis the effect of use of non-convention fuels in IC engine in terms of engine performance, emission and engine's life | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.4 | |
| 27, 28 | Test guidelines for emission measurements | Discuss about tail pipe emissions, their cause and impact on environment | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.4 | Class Quiz/ Home Assignment/End Term |
| 29,30,31 | Emission norms for engines using alternative fuels | Emissions measurement and standards | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.4 | |

| | | | | | |
|---|---|---|---|---|---|
| 32,33 | Legal aspects of blending alternative fuels into conventional liquid fuels | Performance characteristics of liquid alternative fuels | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.4 | |
| 34,35 | Properties of blends | Storage and safety precautions of biodiesel and different issues related to it. | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.5 | |
| 36,37 | Comparison of neat versus blended fuels | Merits and demerits of different liquid alternative fuels. | Lecture/ PPT/ | ME 1656.5 | |
| | | | Discussion & Question Answer Session | | Class Quiz/ Home Assignment/End Term |
| 38 | Fuel testing | ASTM standard of different fuels. | Lecture/ PPT/ Discussion & Question Answer Session | ME 1656.5 | |
| 39 | Conclusion and Course Summarization | Conclude and Summarize | Lecture/ PPT/ Discussion & Question Answer Session | | |

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

| CO | STATEMENT | Correlation with Program Outcomes **(POs)** | | | | | | | | | | | | Correlation with Program Specific Outcomes **(PSOs)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
| **[ ME1656.1 ]** | Describe the effects of air pollution due to automotive vehicles, its effect on global warming and need of alternative fuels. | | **2** | | | | **2** | **3** | | | | | **2** | | **1** | |
| **[ ME1656.2 ]** | Demonstrate engine modification required for the use of gaseous fuels like LPG, CNG, and Hydrogen etc. | | **2** | **2** | | | | **2** | | | | | | | **3** | |
| **[ ME1656.3 ]** | Distinguish different properties of non-petroleum fuels to find suitability of it for IC engine application and availability of these alternative fuels for employability in automobiles sector. | | | | | | **2** | **3** | | | | | | | **2** | |
| **[ ME1656.4 ]** | Examine impact of alternative fuels on IC engine with respect to the formation of pollutants, engine performance and fuel efficiency. | | | | **2** | | | | | | | | | | **3** | |
| **[ ME1656.5 ]** | Evaluate importance of alternative fuel for IC engine, emission characteristic of alternative fuels and legalisation standard of usage of these fuels. | | **2** | | | | **1** | **3** | | | | **1** | **3** | | **3** | |

**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

Advanced Manufacturing Techniques | ME1657 | 3 Credits | 3 0 0 3

Session: Jan 2021 – May 2021 | Faculty: Dr. Ashish Goyal | Class: B. Tech. III Year

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering, The course covers various methods and types of advanced casting, welding processes and non-traditional processes. In a production shop, a successful engineer must have a thorough understanding of the subject if he/she has to select and implement the right processes. To impart knowledge on selection of suitable manufacturing process for the typical component. The selection of the important process parameter is extremely important to achieve the success in manufacturing. The knowledge of correct procedure, machine and parameter leads to the saving of material, rework and labour.

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

**[1657.1].** Know the different advanced manufacturing techniques.
**[1657.2].** Recognize different Non-Traditional machining processes for specific material for improve the technical skills.
**[1657.3].** Explain and differentiate between additive manufacturing and subtractive manufacturing.
**[1657.4].** Describe scope of advance manufacturing techniques for employability in production industries.
**[1657.5]**. Recognize different advanced Casting & Welding process for the entrepreneurship skills.

## 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.

**Programme Specific Outcomes:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I | 15 |
| | Sessional Exam II | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| 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

Rapid Prototyping (RP): Introduction, Characteristics of RP Technologies, Subtractive and Additive Processes, Fused Deposition Modeling, Stereo Lithography, Laminated Object Manufacturing and 3D Printing and Applications of RP. Advanced Casting Processes: Metal Mould Casting, Continuous Casting, Squeeze Casting, Vacuum Mould Casting, Evaporative Pattern Casting, and Ceramic Shell Casting. Advanced Welding Processes: Electron Beam Welding (EBW), Laser Beam Welding (LBW), and Ultrasonic Welding (USW). Non-traditional Machining: Electrical Discharge Machining (EDM), Laser Beam Machining (LBM), Ultrasonic Machining (USM), Electron Beam Machining (EBM), Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Hybrid and Micro Machining Processes.

## F. TEXT BOOKS

1. S. Kalpakjian and S.R. Schmid, *Manufacturing Engineering and Technology*, Pearson Education, 6th Edition, 2009.

2. A. Ghosh, and A.K. Malik, *Manufacturing Science*, Affiliated East West Press Pvt. Ltd., 2nd Edition,

2010.

## G. REFERENCE BOOKS

1. P.C. Sharma, *A text book of Production Technology*, S. Chand and Company, 4th Edition, 2006.

2. R.K. Jain, *Production Technology: Manufacturing Processes, Technology and Automation*", Khanna Publishers, 17th Edition, 2011.

## H. LECTURE PLAN

| Lecture | Topic | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| **L1** | Introduction | Overall review of AMT Subject | Lecture | NA | NA |
| **L2** | Non-traditional Machining | Learn about importance of various non-traditional process and possible area of application. | Lecture/PPT | **[1657.2]** | Quiz |
| **L3 & L4** | Electrical Discharge Machining (EDM) | Identify the specific industrial applications | Lecture/PPT | **[1657.2]** | Machine Tool Lab Visit |
| **L5** | Laser Beam Machining (LBM) | Identify possible area of application. | Lecture/PPT | **[1657.2]** | Quiz |
| **L6 - L7 – L8** | Ultrasonic Machining (USM) | Recall importance of process and possible area of application. | Lecture/PPT | **[1657.2]** | Assignment & Midterm 1 |
| **L9 & L10** | Electron Beam Machining (EBM) | Identify the specific industrial applications | Lecture/PPT | **[1657.2]** | Assignment |
| **L11 – L12** | Abrasive Jet Machining (AJM) | Identify possible area of application. | Lecture/PPT | **[1657.2]** | Midterm 1 |
| **L13 – L14 – L15** | Abrasive Water Jet Machining (WJM) | Recall importance of process and possible area of application. | Lecture/PPT | **[1657.2]** | Quiz |
| **L16** | Hybrid and Micro Machining Processes. | Describe and distinguish between macro and micro machining | Lecture/PPT | **[1657.2]** | Midterm 1 |

| | | | | | |
|---|---|---|---|---|---|
| **L17** | Advanced Casting Process – Introduction | Learn about importance of various Advanced Casting process and possible area of application. | Lecture/PPT | **[1657.5]** | Assignment & Quiz |
| **L18** | Metal Mould Casting | Learn about various applications of and its usage | Lecture/PPT | **[1657.5]** | Midterm 1 |
| **L19** | Continuous Casting | Employ the specific casting for a specific product | Lecture/PPT | **[1657.5]** | Assignment & Midterm 1 |
| **L20** | Squeeze Casting | Describe squeeze casting | Lecture/PPT | **[1657.5]** | Assignment & Midterm 1 |
| **L21** | Vacuum Mould Casting | Recall importance of process and possible area of application. | Lecture/PPT | **[1657.4]** | Assignment & Quiz |
| **L22** | Evaporative pattern Casting | Identify possible area of application. | Lecture/PPT | **[1657.4]** | Assignment & Quiz |
| **L23** | Ceramic Shell Casting | Learn about various applications of and its usage | Lecture/PPT | **[1657.5]** | Assignment |
| **L24** | Advanced Welding Processes – Introduction | Learn about importance of various Advanced welding process and possible area of application. | Lecture/PPT | **[1657.5]** | Assignment |
| **L25** | Electron Beam Welding | Recall importance of process and possible area of application. | Lecture/PPT | **[1657.4]** | Assignment & Quiz |
| **L26** | Laser beam Welding | Identify possible area of application. | Lecture/PPT | **[1657.5]** | Assignment & Quiz |
| **L27** | Ultrasonic Welding | Identify possible area of application. | Lecture/PPT | **[1657.4]** | Assignment |
| **L28** | Rapid Prototyping (RP) – Introduction & Types | Student will distinguish types of RP | Lecture/PPT | **[1657.3]** | Mid-Term 2 Quiz |
| **L29** | Different features of RP | Student will be able to understand features of RP | Lecture/PPT | **[1657.3]** | Quiz |
| **L30** | Different features of RP & Rapid Tooling | Differentiate different features of RP | Lecture/PPT | **[1657.3]** | Mid-Term 2 Quiz |

| | | | | | |
|---|---|---|---|---|---|
| **L31** | Subtractive Manufacturing | Learn about different features of subtractive manufacturing | Lecture/PPT | **[1657.3]** | Assignment |
| **L32** | Additive Manufacturing | Study different characteristics of additive manufacturing | Lecture/PPT | **[1657.3]** | Mid-Term 2 Quiz |
| **L33** | Fused Deposition Modelling | Understand in detail about fused deposition modelling | Lecture/PPT | **[1657.3]** | Mid-Term 2 |
| **L34** | Stereo-lithography - Introduction | Will know the significance of SL | Lecture/PPT | **[1657.3]** | Mid-Term 2 & Quiz |
| **L35** | Selective laser Sintering - Introduction | Can understand the importance of SLS | Lecture/PPT | **[1657.3]** | Quiz |
| **L36** | Selective laser Sintering | Will judge the features of SLS | Lecture/PPT | **[1657.3]** | Mid-Term 2 Quiz |
| **L37** | 3 D Printing | Describe 3 D printing and its applications | Lecture/PPT | **[1657.3]** | Mid-Term 2 Quiz |
| **L38** | Direct Manufacturing | Recall importance of process and possible area of application. | Lecture/PPT | **[1657.3]** | Mid-Term 2 Quiz |
| **L39** | Rapid Tooling | Describe Rapid tooling and its applications | Lecture/PPT | **[1657.3]** | Mid-Term 2 Quiz |
| **L40** | Applications of RP | Learn about various applications of and its usage | Lecture/PPT | **[1657.3]** | Mid-Term 2 Quiz |
| **L41** | Revision of AMT | Revision | NA | **NA** | NA |

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

| | **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 |
| **[1657.1]** | Know the different advanced manufacturing techniques. | 2 | | | | 2 | | | | | | | | | | 2 |
| **[1657.2]** | Recognize different Non-Traditional machining processes for specific material. | 2 | 1 | | | | | | | | | | | | | 2 |
| **[1657.3]** | Explain and differentiate between additive manufacturing and subtractive manufacturing | 2 | 2 | | 1 | | 2 | 1 | | | | | | | | 2 |
| **[1657.4]** | Describe scope of advance manufacturing techniques in production industries. | 2 | 1 | | 1 | | 1 | | | | | | | | | 2 |
| **[1657.5]** | Explain different advanced Casting & Welding process. | 2 | 2 | | | | 1 | | | | | | | | | 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

Production and Operations Management | ME 1658| 3 Credits | 3 0 0 3

Session: Jan 21 – May 21 | Faculty: Dr R. K. Gupta | Class: VI Semester (B.Tech.)

**A. Introduction**: This course is offered by Dept. of Mechanical Engineering for 6th Semester B Tech Mechanical Engineering students, who wish to pursue specialization course or higher studies in the field of Production and Operation Management or research & development in industries. It offers in depth knowledge of technical skills and intellectual discipline needed by our students to become leaders in the field of production and operations management and related professions. This course provides the comprehensive knowledge on fundamentals of management, detailed study of production planning, operations management, forecasting and methodology of layout planning. It deals with industrial application and basic of planning of any industry regarding its production and operations.

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

**[ME 1658.1].** Understand the objectives, scope and functions of production and operations management.

**[ME 1658.2].** Design and develop the new product or modify the existing products as per market requirements.

**[ME 1658.3].** Analyse and evaluate the forecasting through understanding various qualitative and quantitative techniques and enhance their skill and make them employable.

**[ME 1658.4].** Design the production planning, aggregate planning, master production schedule and production control.

**[ME 1658.5]** Understand the types of plant layouts and methodology to layout planning.

## 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.

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

### C. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |

| | | |
|---|---|---|
| End Term Exam | End Term Exam (Closed Book) | 40 |
| (Summative) | | |
| | 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 to production and operations management: Objectives, scope and functions of production management, planning, organizing, controlling in operations management. Production and process design: Needs for product design and development, product selection, modifying the existing products. Forecasting: Concept, basic elements, classification, purpose of sales forecasting, qualitative and quantitative techniques of forecasting. Production planning and control: Nature, types, elements, types of plans, strategy and aggregate production planning, master production schedule, production control. Plant location and layout: Types of layout, methodology of layout planning.

## F. Text Books:

1. W. J. S. Irwin, Operation Management, McGraw Hill Publication, 9th Edition, 2005.
2. S. Paton, B. Clegg, J. Hsuan, and A. Pilkington, Operations Management, McGraw Hill Publication, 2011

## G. References:

1. K. Aswathappa, S. Bhat, Production and Operations management, Himalaya Publication, 2nd Edition, 2015.

## H. Lecture Plan:

**Production and Operations Management: (ME 1658)**

| Lecture Number | Topic to be covered |
|---|---|
| L1 | Objectives and scope of Production Management |
| L2 | Functions of Production Management |
| L3 | Functions of Operations Management |
| L4 | Planning, organizing, controlling in operations management |
| L5 | Needs for product design and development |
| L6 | Product selection |
| L7 | Modifying the existing products |
| L8 | Concepts of Forecasting |
| L9 | Basic elements of forecasting |
| L10 | Classifications of forecasting |
| L11 | Purpose of sales forecasting |
| L12 | Qualitative and quantitative techniques of forecasting |
| L13 | Time series methods |
| L14 | Regression methods. |
| L15 | Accuracy and control of forecasts. |
| L16 | Production planning objective and functions |
| L17 | Bill of material. |
| L18 | Capacity and man power requirement planning |
| L19 | Planning levels: long range, Intermediate range and Short range planning |
| L20 | Objective, Strategies of Aggregate Planning |
| L21 | Graphical and mathematical techniques of aggregate planning |
| L22 | Master production scheduling |
| L23 | MRP and MRPII Systems |
| L24 | Capacity control and priority control. |
| L25 | Production control functions |
| L26 | Routing, scheduling, dispatching, expediting and follow up |
| L27 | Techniques of production control in job shop production. Batch production and mass production systems. |
| L28 | Types of Plant layout |
| L29 | Methodology of Plant layout planning |
| L30 | Revision |
| Quiz | Five Quiz to be conducted |

## I. 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 |
| **[ME 1658.1]** | Understand the objectives, scope and functions of production and operations management. | 1 | 1 | 2 | 2 | 2 | 1 | | | 1 | 2 | 2 | 1 | | | |
| **[ME 1658.2]** | Design and develop the new product or modify the existing products as per market requirements. | | 1 | 2 | 2 | 2 | 1 | | | 1 | 2 | 2 | 1 | | | |
| **[ME 1658.3]** | Analyse and evaluate the forecasting through understanding various qualitative and quantitative techniques. | 1 | 1 | 2 | 2 | 1 | 1 | | | 1 | 2 | 1 | 1 | | | |
| **[ME 1658.4]** | Design the production planning, aggregate planning, master production schedule and production control. | | 1 | 2 | 2 | 3 | 1 | | | 1 | 2 | 2 | 1 | | | |
| **[ME 1658.5]** | Understand the types of plant layouts and methodology to layout planning. | | 1 | 2 | 2 | 2 | | | | 1 | 2 | 2 | 1 | | | |

**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
Heat Treatment | ME 1659 | 3 Credits | 3 000
Session: Jan 21 – May 21 | Faculty: Mr. ANKUR SRIVASTAVA | Class:B.Tech VIth Semester

**A. Introduction**: This course is offered by Dept. of Mechanical Engineering for VI th semester students of B. Tech, targeting students to learn the fundamental of physical, and mechanical properties of metallic and non-metallic alloys and how to improve the mechanical properties using variant methods of heat treatment methods. This course will help in any field that produces/manufacture and maintenance of automobile and mechanical components. The knowledge of heat treatments processes undergraduate engineers will be able to modify and tailor and properties to develop and review the different manufacturing processes and its applications.

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

**[ME 1659.1].** Understand the basics of mechanical properties of alloys.

**[ME 1659.2].** Analyze the mechanics of phase changes of alloys during heat treatments processes.

**[ME 1659.3].** Understand various heat treatment methods and their applications for employability in industries.

**[ME 1659.4].** Analyze the heating rate determination and characteristics of heat treating.

**[ME 1659.5].** Demonstrate heat treatment processes

**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.

**PROGRAM SPECIFIC OUTCOMES:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (close Book) | 40 |
| | Total | 100 |
| Attendance (Formative) | A minimum of 75% Attendance is required to be mainta ined 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<br><br>(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/ Activit y 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: Heat Treatment Processes: Annealing- its types and effect on mechanical properties, Normalizi ng, Hardening, Tempering, Surface hardening, Quenching. Chemical heat treatment of steels: Carburising and its types, post carburizing treatments, Cyaniding and Carbonitriding, Nitriding, Plasma nitriding, Boronizing & Chromizing, Hardenability. Elements of heat treatment process including heating rate determination and characteristics of heat treating furnaces, finishing operations, Heat treatment of tools, Heat treatment and application of Non-ferrous metals and alloys.

**F. Text Books:**

1. T.V. Rajan, C.P. Sharma and A. Sharma, *Heat treatment principles and techniques*, Prentice Hall Publishers, 2nd Edition, 2010.
2. W. Bolton, *Engineering materials technology*, Heinmann Newness, 3rd Edition, 2001.

**G. References:**

1. B. Zakharov, *Heat treatment of Metals*, Mir Publishers, 1st Edition, 2002.

**H. Lecture Plan:**

| Lecture Number | Topic to be covered | Assignment and Quiz test details |
|---|---|---|
| L1 | Heat Treatment Processes | **Assignment -1**<br>**Quiz test-1** |
| L1 | Heat Treatment Processes | |
| L2 | Types of Engineering Alloys | |
| L3 | Mechanical, Physical and chemical properties | |
| L4 | Engineering Structures of alloys | |
| L5 | Annealing- its types and effect on mechanical properties | |
| L6 | Annealing- its types and effect on mechanical properties | |
| L7 | Case study on annealing of mechanical component | |
| L8 | Normalizing: Introduction and applications | |

| | | |
|---|---|---|
| L9 | Normalizing: Mechanism and process | **Assignment -2**<br>**Quiz test - 2** |
| L10 | Hardening: : Introduction and applications | |
| L11 | Hardening: Mechanism and process | |
| L12 | Case study on hardening of mechanical parts | |
| L13 | Tempering: Introduction and applications | |
| L14 | Tempering: Mechanism and process | |
| L15 | Case study on tempering of mechanical components | |
| L16 | Surface hardening | |
| L17 | Surface hardening | |
| L18 | Quenching. | |
| L19 | Quenching. | |
| L20 | Chemical heat treatment of steels: Carburising and its types | **Assignment -3**<br>**Quiz test - 3** |
| L21 | Chemical heat treatment of steels: Carburising and its types | |
| L22 | post carburizing treatments | |
| L23 | Cyaniding and Carbonitriding | |
| L24 | Cyaniding and Carbonitriding | |
| L25 | Nitriding | |
| L26 | Plasma nitriding | |
| L27 | Hardenability | **Assignment -4**<br>**Quiz test - 4** |
| L28 | Elements of heat treatment process including heating rate determination and characteristics of heat treating furnaces | |
| L29 | Heat treatment of tools | |
| L30 | Heat treatment and application of Non-ferrous metals and alloys. | |
| L31 | Chromizing | |
| L32 | Boro-nizing | |
| L33 | Case study -1 | |
| L34 | Case study-2 | |
| L35 | Case study 3 | |
| L36 | Case study -4 | |
| L37 | Case study -5 | |

| 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 |
| **[ME 1659.1]** | Understand the basics of mechanical properties of alloys. | **1** | | | | **1** | | | | | | | | | | |
| **[ME 1659.2]** | Analyse the mechanics of phase changes of alloys during heat treatments processes. | **1** | | **2** | | **2** | | | | | | | | | | |
| **[ME 1659.3]** | Understand various heat treatment methods and their Applications for employability in industries | **1** | | **2** | | **2** | | | | | | | | | | |
| **[ME 1659.4]** | Analyse the heating rate determination and characteristics of heat treating. | **1** | **1** | | | | | | | | | | | | | |

**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

Automatic Control Engineering | ME1660| 3 Credits | 3 0 0 3

Session: Jan 21-May 21 | Faculty: Dr. Ramanpreet Singh| Class: B. Tech MECHANICAL VI SEM

**A. Introduction:** This course shall introduce the fundamentals of modeling and control of linear time invariant systems; primarily from the classical viewpoint of Laplace transforms and a brief emphasis on the state space formulation as well. The course will be useful for students from major streams of engineering to build foundations of time/frequency analysis of systems as well as the feedback control of such systems

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

**[ME 1660.1]** Remember the notion of control for engineering applications

**[ME 1660.2]** Understand the mathematical modelling for different mechanical and electrical systems

**[ME 1660.3]** Analyse and reduce the complex systems by using block diagram reduction technique

**[ME 1660.4]** Develop a skill set in checking the stability using pole location and Routh Hurwitch criteria

**[ME 1660.5]** Analyze and review the stability using the root locus

## 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.

**PROGRAM SPECIFIC OUTCOMES**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I | 15 |
| | Sessional Exam II | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| 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 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

**Concepts:** Simple open and closed loop systems, concept of feedback, block diagrams, transfer functions. Representation of Control Components and Systems Representation, **System Responses:** Damping ratio and natural frequency, First order and second order system response to step input, Ramp input and sinusoidal input, response of a system to external disturbance, **Frequency Response:** Polar and rectangular plots for the frequency response, graphical view point, System Analysis using logarithmic plots, **Bode diagrams**: Stability analysis using Bode diagrams, simplified Bode diagrams System Analysis using Root locus Plots, Root Locus plots for simple transfer functions, graphical relationships setting the system gain, system transient response, system frequency response, **System compensation**, Digital Computer Control, State Space Analysis of Control Systems.

## F. REFERENCE BOOKS

1. K. Ogata, Modern control engineering, 5t h edition, Prentice Hall India Publishers, Delhi
2. R. C. Dorfand, R. H. Bishop, Modern Control Systems, 8t h edition, Addison Wesley Longman Publications, 1998
3. I. J. Nagrath and M. Gopal, Control Systems engineering, 4t h edition, New Age International Publications.
4. B. C. Kuo, F. Golnaraghi, Automatic Control Systems, 8t h edition, Wiley Publishers, India, 2003
5. J. D. Azzo John and H. Houpis Constantine, Feedback control system analysis and synthesis, McGraw Hill publications, New York, 2007

**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 | Simple open and closed loop systems | To ascertain the interest and recapitulate the understanding and the existing knowledge of Control Systems | Interaction, Discussion & Question Answer Session | CO 1 | In Class Quiz ( Not Accounted) |
| 3 | Simple open and closed loop systems | To acquaint the basic comprehension of Transfer function | Lecture<br><br>Interaction | CO 1 | 1st Sessional<br><br>ET Exam<br><br>Home Assignment |
| 4 | Concept of feedback, block diagrams | To familiarize the basic comprehension of mathematical modelling | Lecture<br><br>Interaction | CO 1 and CO 2 | |
| 5 | Concept of feedback, block diagrams | To familiarize the notion of translational and rotation systems | PPT | CO 2 | |
| 6 | Block diagram algebra: Definition, how to convert electrical systems into block diagram. Rules for block diagram reduction(BDR) | To familiarize the notion of translational and rotation systems | Lecture<br><br>Interaction | CO 1 and CO 2 | 1st Sessional<br><br>ET Exam<br><br>Home Assignment |
| 7 | Rules for block diagram reduction (BDR) continue, problems based on BDR. | To acquaint the basic comprehension of block diagrams | Lecture<br><br>Interaction | CO 2 | |
| 8 | Transfer functions | To acquaint the basic comprehension of signal flow graphs | PPT | CO 2 | |
| 9 | Transfer functions (Illustrations) | To introduce the application of Mason's gain formula | Lecture<br><br>Interaction | CO 2 | |

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|---|---|---|---|---|---|
| 10 | Representation of Control Components and Systems Representation | To introduce the conversions of block diagrams into SFG | Lecture<br><br>Interaction | CO 2 | |
| 11 | Representation of Control Components and Systems Representation | To introduce the application of SFG | PPT | CO 2 | 1st Sessional |
| | | | | | ET Exam<br><br>Home Assignment |
| 12 | Damping ratio and natural frequency | To introduce the application of BDR and SFG | Lecture<br><br>Interaction | CO 3 | |
| 13 | Damping ratio and natural frequency | To introduce the application of Feedback Theory | PPT | CO 2 | |
| 14 | First order and second order system response to step input | To introduce the application of Regenerative and degenerative feedback. | PPT | CO 2 and CO3 | 1st Sessional<br><br>ET Exam<br><br>Home Assignment |
| 15 | First order and second order system response to step input | To introduce the application of Regenerative and degenerative feedback. | PPT | CO 2 and CO3 | |
| 16 | First order and second order system response to ramp input | To introduce the application of Components of control system: AC Servomotor | PPT | CO 2 and CO 3 | |
| 17 | First order and second order system response to sinusoidal input | To introduce the application of Components of control system: DC Servomotor | PPT | CO 2 and CO 3 | 1st Sessional<br><br>ET Exam<br><br>Home Assignment |
| **FIRST SESSIONAL EXAM** | | | | | |
| 18 | Response of a system to external disturbance, | To introduce the Concept of Time domain analysis | Lecture<br><br>Interaction | CO 3 | |
| 19 | Response of 2nd order system to unit step input | To introduce the Concept of Response of 2nd order system to unit step input | Lecture<br><br>Interaction | CO 3 | |
| 20 | Polar and rectangular plots for the frequency response | To introduce the application of Response of 2nd order system to unit step input | Lecture<br><br>Interaction | CO 3 and CO 4 | 1st Sessional<br><br>ET Exam<br><br>Home Assignment |

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|---|---|---|---|---|---|
| 21 | Graphical view point, System Analysis using logarithmic plots | To introduce the Concept of Response of 2nd order system to unit step input | Lecture<br><br>Interaction | CO3 and CO 4 | |
| 22 | Stability analysis using Bode diagrams and Routh Hourwitzh | To introduce the Concept of Steady state error and error constants | Lecture<br><br>Interaction | CO 4 | |
| 23 | Simplified Bode diagrams System Analysis using Root locus Plots | To introduce the Concept of Generalized error series | Lecture<br><br>Interaction | CO 4 | 1st Sessional<br><br>ET Exam |
| | | | | | Home Assignment |
| 24 | Root Locus plots for simple transfer functions | To introduce the Concept of stability | Lecture<br><br>Interaction | CO 5 | |
| 25 | Rules to construct RL | To introduce the Concept of Concept of stability | Lecture<br><br>Interaction | CO 5 | |
| 26 | Rules to construct RL continue. Small examples can be taken to make understand the rules properly. | To introduce the Concept of Root locus | Lecture<br><br>Interaction | CO 5 | 2ndSessional<br><br>ET Exam<br><br>Home Assignment |
| 27 | Simple problems for RL | To introduce the Concept of Root locus | Lecture<br><br>Interaction | CO 5 | |
| 28 | Simple problems for RL | To introduce the Concept of Root locus | Lecture<br><br>Interaction | CO 5 | |
| **SECOND SESSIONAL EXAM** | | | | | |
| 29 | More difficult problems for RL | To introduce the Applications of Root locus | Lecture<br><br>Interaction | CO 5 | 2nd Sessional<br><br>ET Exam<br><br>Home Assignment |
| 30 | System transient response, system frequency response | To introduce the Applications of Root locus | Lecture<br><br>Interaction | CO 4 and CO5 | |
| 31 | System transient response, system frequency response | To introduce the Applications of Root locus | PPT | CO 4 and CO5 | |
| 32 | Digital Computer Control | To introduce the Applications of Frequency domain analysis | PPT | CO 1 | 2ndSessional<br><br>ET Exam<br><br>Home Assignment |
| 33 | State Space Analysis of Control Systems. | To introduce the Applications of Bode plot | PPT | CO 1 | |

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|---|---|---|---|---|---|
| 34 | State Space Analysis of Control Systems. | To introduce the Applications of Bode plot | Lecture<br><br>Interaction | CO 1 | |
| 35 | Revision | To introduce the Applications of Bode plot | Lecture<br><br>Interaction | | 2nd Sessional<br><br>ET Exam<br><br>Home Assignment |
| 36 | Revision | To introduce the Applications of Bode plot | Lecture<br><br>Interaction | | |
| **END TERM EXAM** | | | | | |

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

| CO | STATEMENT | Correlation with Program Outcomes **(POs)** | | | | | | | | | | | | Correlation with Program Specific Outcomes (**PSOs**) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
| **[ME 1660.1]** | Remember the notion of control for engineering applications | **3** | | | | | | | | | | | | | | | | |
| **[ME 1660.2]** | Understand the mathematical modelling for different mechanical and electrical systems | **3** | **2** | | | | | | | | | | | | | | | |
| **[ME 1660.3]** | Analyse and reduce the complex systems by using block diagram reduction technique | **1** | **2** | **1** | | | | | | | | | | | | | | |
| **[ME 1660.4]** | Develop a skill set in checking the stability using pole location and Routh Hurwitch criteria. | **3** | **1** | **1** | | | | | | | | | **1** | **1** | | | | |
| **[ME 1660.5]** | Analyze and review the stability using the root locus | **3** | **2** | **1** | | | | | | | | | | | | | | |

**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

**REFRIGERATION AND AIR CONDITIONING| ME 1706 | 3 Credits | 3 0 0 3**

Session: July 20 – Dec 20 | Faculty: Pooja Singh

**INTRODUCTION:** This course is offered by Dept. of Mechanical Engineering, targeting students who wish to pursue research & development in industries or higher studies in field of Mechanical engineering. In this course we aimed to make the students familiar with the application of thermodynamics in the field of refrigeration and air conditioning. Further to explain the basic working and principle involved in refrigeration, air conditioning, refrigerants, Psychometry of air conditioning processes and to explain vapour compression and vapour absorption cycle systems.

## A. COURSE OUTCOMES: At the end of the course, students will be able to

**[1706.1].** Apply different laws and basic concept of refrigeration and air conditioning processes in daily life engineering applications.

**[1706.2].** Analyse the concept of vapour compression cycle systems and its application in air conditioning.

**[1706.3].** Analyse the concept of vapour absorption systems and its application in air conditioning.

**[1706.4].** Analyse the various classes of refrigerants its compatibilities and selection methodology and concept of gas refrigeration cycle.

**[1706.5].** Comprehend the basic definitions and terminology of psychrometry and air conditioning for entrepreneurial skills.

## B. 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

**PROGRAMME SPECIFIC OUTCOMES**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## C. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional quizzes and assignments | 60 % |
| End Term Exam (Summative) | End semester examination | 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 | |

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| | awarded. |

## D. SYLLABUS

**Basic refrigeration cycles**: reverse Carnot cycle, effect of temperatures, Air refrigeration cycles, Bell-colemen cycle, Air refrigeration cycles for aircrafts; **Theoretical vapour compression cycle**: Compound vapour compression refrigeration system, Multi-evaporator and cascade systems, Ammonia Absorption refrigeration, Lithium Bromide Absorption system, Absorption versus compression systems, Refrigerants by class, CFC, HFC and HCFC refrigerant blends, comparison of thermodynamic properties of refrigerants, steam jet refrigeration; **Air Conditioning**: psychrometric properties and charts, psychrometric of air-conditioning process, summer and winter air conditioning, calculation of heating and cooling loads, design of air conditioning systems, air-duct design, cold storage system.

**Text Books:**


1. S.C.Arora and S.Domkondwar, *A Course in Refrigeration and Air conditioning*, Danpath Rai, New Delhi, 1996.
2. Cook Norman, *Refrigeration and Air conditioning*, Macmillan London, 1989.
3. W.F.Stocker, *Refrigeration and Air conditioning*, Tata McGraw Hill, 1985.


**References:**


1. Prasad Manohar*, Refrigeration and Air conditioning*, New Age International, 2007

## A. Lecture Plan:

| Lect. No | **Topics** | **Session Outcome** | **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 | NA |
| 2 | Refrigeration and Air conditioning – Introduction | Revision of Basic thermodynamics and Refrigeration | Lecture | ME 1706.1 | Class Quiz |
| 3 | Introduction to Reversed Carnot cycle | Recall the working principle of Reversed Carnot cycle | Lecture | ME 1706.1 | Class Quiz<br>Mid Term 1<br>End Term |
| 4 | Limitations of Carnot cycle with gas as refrigerant | Understanding of problems associated with reversed Carnot cycle in practical applications | Lecture | ME 1706.1 | Class Quiz<br>Mid Term I<br>End Term |
| 5, 6 | Reversed Brayton (Bell Coleman) cycle | Discussion on Reversed Brayton working principle, system calculations on Reversed Brayton cycle | Lecture | ME 1706.4 | Class Quiz<br>Mid Term I<br>End term |
| 7, 8 | Air refrigeration cycles for aircrafts | Understanding the basics of air refrigeration cycles for aircrafts and simple aircraft refrigeration cycle with ram compression, problem solving capabilities of students on air refrigeration cycles for aircrafts | Lecture | ME 1706.4 | Class Quiz<br>Mid Term I<br>End Term |
| 9 | Vapour compression cycle-Introduction | Understanding the basics of vapour compression refrigeration systems, modification of reversed Carnot cycle with vapour as coolant | Lecture | ME 1706.2 | Class Quiz<br>Mid Term I<br>End Term |
| 10,11 | Ideal Vapour compression system | Understanding the concept of Ideal vapour compression system calculations | Lecture | ME 1706.2 | Home Assignment<br>Class Quiz<br>Mid Term 1<br>End Term |
| 12,13 | Different types of VCR cycles | Understanding the concept of Ideal vapour compression system calculations | Lecture | ME 1706.2 | Class Quiz<br>Mid Term 1<br>End Term |
| 14 | Actual Vapour Compression cycle | Understanding how and why it differs from ideal VCR cycle | Lecture | ME 1706.2 | Mid Term 1 |
| 15,16 | Methods of improving the COP of VCR cycle | Understanding the use of Flash chamber, intercooler etc. | Lecture | ME 1706.2 | Mid Term 1<br>End Term |

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|---|---|---|---|---|---|
| 17,18 | Multi-stage vapour compression refrigeration systems | Problem solving capabilities of students on multi-stage vapour compression system | Lecture | ME 1706.2 | Class Quiz<br>Mid Term II<br>End Term |
| 19 | Cascade vapour compression cycles | Understanding the system calculations on cascade VC cycles | Lecture | ME 1706.2 | Class Quiz<br>Mid Term II<br>End Term |
| 20 | Simple Vapour -Absorption systems- Introduction | Understanding the basics of Vapour -Absorption systems, $NH_3$ system. | Lecture, Activity | ME 1706.3 | Class Quiz<br>Mid Term II<br>End Term |
| 21, 22 | Lithium bromide absorption systems | Understanding the basics of Lithium bromide absorption systems and its system calculations | Lecture | ME 1706.3 | Class Quiz<br>Mid Term II<br>End Term |
| 23 | Comparison of vapour compression and absorption cycle | Understanding the relation between the Vapour compression and vapour absorption systems | Lecture | ME 1706.3 | Class Quiz<br>Mid Term II<br>End Term |
| 24 | Refrigerants-Introduction | Discussion on class of Refrigerants, CFC, HFC and HCFC refrigerant blends | Lecture | ME 1706.4 | Class Quiz<br>Mid Term II<br>End Term |
| 25 | Designation of refrigerants, selection of refrigerants | Thermodynamic, chemical and physical requirements of refrigerants | Lecture | ME 1706.4 | Class Quiz<br>Mid Term II<br>End Term |
| 26 | Basics of properties of Moist air | Discussion on Psychometric properties of moist air | Flipped Class | ME 1706.5 | Class Quiz<br>Mid Term II<br>End Term |
| 27 | Psychrometry- Introduction | Discussion on Psychometric properties and chart. | Lecture | ME 1706.5 | Class Quiz<br>End Term |
| 28 | Psychometric Chart | Understanding the use of psychometric chart | Lecture | ME 1706.5 | Class Quiz<br>End Term |
| 29,30 | Various psychometric processes | Understanding the psychometric Processes & evaluation of properties from Psychometric charts | Lecture | ME 1706.5 | Class Quiz<br>End Term |
| 31 | Air mixing Systems | Basic of adiabatic mixing of air, Assignments on Dew point and Wet bulb temperature for air mixing Systems and basic processes in air conditioning | Lecture | ME 1706.5 | Class Quiz<br>End Term |
| 32, 33 | Summer and Winter air conditioning processes, Design methodology for air conditioning systems | Developments of problem solving capabilities of students on summer and Winter air conditioning processes | Lecture | ME 1706.5 | Class Quiz<br>End term |
| 34 | Cooling Load Calculations | Understanding the cooling loads and their calculation. | Lecture | ME 1706.5 | Class Quiz<br>End Term |

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|---|---|---|---|---|---|
| 35, 36 | Design of Air Conditioning system | Understanding how to design an air conditioning system & allied calculations | Lecture | ME 1706.5 | Class Quiz<br>End Term |
| 37 | Conclusion and Course Summarization | NA | NA | | Class Quiz |

**E. 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 |
| ME 1706.1 | Apply different laws and basic concept of refrigeration processes in daily life engineering applications. | 3 | 1 | | | | 2 | | | | | | 2 | 1 | | |
| ME 1706.2 | Analyse the concept of vapour compression cycle systems and its application in air conditioning. | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 2 | |
| ME 1706.3 | Analyse the concept of vapour absorption systems and its application in air conditioning. | 3 | 3 | 1 | 1 | | | | | | | | | 2 | 2 | |
| ME 1706.4 | Analyse the various classes of refrigerants, its compatibilities and selection methodology and concept of gas refrigeration cycle. | 3 | 3 | 1 | 2 | | | 1 | | | | | | 2 | | 2 |
| ME 1706.5 | Comprehend the basic definitions and terminology of psychrometry and air conditioning for entrepreneurial skills. | 3 | 1 | | | 2 | | | | | | | | 1 | | |

**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

Mechanical Vibration | ME 1707 | 4 Credits | 4 0 0 4

Session: July20 – Dec 20 | Faculty: Prof. N.N. Sharma/Mr. Arpit Khandelwal/ Mr. Rakesh Kumar

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering as compulsory course for 7th semester students. This course is required to learn designing of mechanical systems and parameters those affect their working. It is also targeting students who wish to pursue research & development in industries or higher studies in field of mechanical system design. This course offers in depth knowledge of causes of vibration generation in different mechanical systems e.g. IC Engine, Turbines, compressors and other moving objects and also make student to learn how to prevent vibration in these systems. Students are expected to have background of mechanics and calculus.

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

[1707.1] Describe and identify causes and effects of vibration in mechanical systems

[1707.2] Construct linear vibratory models of different dynamic systems (e.g. linear and torsional) with different complexities like SDOF, MDOF

[1707.3]. Develop the differential equation of motion of vibratory systems using different approaches and solve the equations to get modes and mode shapes

[1707.4]. Analyse of free and forced (harmonic, periodic) vibration for single and multi-degree using different methods

[1707.5]. Develop skills for mathematical modelling of lumped and continuous systems using MATLAB (e.g. string and rod)

## 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.

**Programme Specific Outcomes**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 15 |
| | Sessional Exam II (Closed Book) | 15 |
| | Quizzes and Assignments and computer based test | 30 |
| End Term Exam (Summative) | End Term Exam (Open 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

Introduction to vibration, Longitudinal, Lateral and torsional vibration systems, Single degree of freedom, Free and forced Vibration: Equation of motion, Viscous and Coulomb damped vibration, whirling of shaft. Harmonic forced vibration, Rotary and reciprocating unbalance, Vibration isolation, Periodic and impulse vibration, Two degrees of freedom systems, Equation of motion using classical methods, Modal analysis using Eigen method, Vibration absorber. Multi degree freedom systems, Flexibility and stiffness matrices,

Iterative methods: Holzer method, Matrix iteration, Rayleigh and Dunkerley's methods for modal analysis. Torsional vibration: Multi Degree of Freedom system, Geared system. Introduction to continuous systems.

.

## F. TEXT BOOKS

1. S.S.Rao, Mechanical Vibration, Pearson Education, Delhi, 6th Edition

2. G.K. Groover, Mechanical Vibration, Nem Chand & Bros, 8th edition

**G. REFERENCE BOOKS**

1. W.T.Thomson, Theory of Vibrations with Applications, Chapman and Hall, 4th Edition,1993
2. J.D.Imnan, Engineering Vibration, Prentice Hall, New Delhi, 2001
3. S. Graham Kelly, Mechanical Vibration: Theory and Application, Global Engineering.

**H. Lecture Plan:**

| Lec No | **Topics** | **Session Outcome** | **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 | NA |
| 2 | Introduction: Definition of Degrees of Freedom with examples | Recall of Degree of freedom with examples | Flipped Classroom | 1707.1 | In Class Quiz |
| 3 | Analysis using Newton's classical method and energy method | Understanding of Newton's classical method and energy method | Lecture | 1707.1 | In Class Quiz<br>End Term, Mid term 1, Mid term 2 |
| 4 | Introduction to Longitudinal, Lateral and Torsional systems (undamped free vibration) | Explain types of vibration | Lecture | 1707.1 | Home Assignment<br>End Term |
| 5 | Effect of spring mass on natural frequency and Springs in series and parallel | Arrangement of springs | Lecture | 1707.2 | In Class Quiz<br>End Term |
| 6 | Problems based on vibration of lever | Able to make governing equations | Flipped Class | 1707.2 | Class Quiz<br>Mid Term I<br>End Term |
| 7 | Problems based on vibration of pulley | Able to make governing equations and natural frequency | Flipped Class | 1707.2 | Class Quiz<br>Mid Term I<br>End term |
| 8 | Problem solving Using MATLAB Programming for undamped free vibration | Able to write program to solve governing equation of motion | Lecture | 1707.5 | Class Quiz |

| | | | | | |
|---|---|---|---|---|---|
| 9-11 | Other miscellaneous problems | practice for forming of governing equations for various system | Lecture | 1707.2 | Class Quiz<br>Mid Term I<br>End term |
| 12 | Damped free vibration | Understanding of effect of damping on vibration | Activity (Think Pair Share) | 1707.2 | Class Quiz<br>Mid Term I<br>End Term |
| 13 | Over damped and critical damped systems | Develop understanding of various types of damped system and able to differentiate them | Lecture | 1707.2 | Class Quiz<br>Mid Term I<br>End Term |
| 14 | Under damped systems and logarithmic decrement | Able to determine the response of underdamped system | Lecture | 1707.2 | Class Quiz<br>End Term |
| 15 | Problems based on damped free vibration | Able to apply the concepts to real life problems | Lecture | 1707.4 | Class Quiz<br>Mid Term II |
| 16 | Problem solving Using MATLAB Programming for damped free vibration | Able to write program to solve governing equation of motion and finding damping effect | Lecture | 1707.5 | Class Quiz |
| 17 | Forced vibration (periodic and Aperiodic) | Explain difference between free and forced vibration | Lecture, Activity | 1707.4 | Class Quiz<br>Mid Term II<br>End Term |
| 18 | Forcing due to unbalance | Describe the nature of vibration due to rotating and reciprocating unbalance | Lecture, Activity | 1707.4 | Class Quiz<br>Mid Term II<br>End Term |
| 19 | Forcing due to support motion | Understanding of effect of motion transmissibility | Lecture | 1707.4 | Class Quiz<br>Mid Term II<br>End Term |
| 20 | Vibration Isolation and transmissibility | Understanding of isolation and force transmissibility | Lecture | 1707.4 | Class Quiz<br>End Term |
| 21-22 | Problems based on forced vibration | Able to apply concepts to the problems | Flipped Class | 1707.4 | Class Quiz<br>End Term |
| 23 | Problem solving Using MATLAB Programming for forced vibration | Able to write program to solve governing equation of motion and finding response | Lecture | 1707.5 | Class Quiz |
| 24-26 | Natural frequency and modes of vibration using classical method for Two DOF system | Understanding of modes of vibration | Flipped Class | 1707.4 | Class Quiz<br>End Term |

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|---|---|---|---|---|---|
| 27-29 | Problems on two DOF systems | Able to apply Lagrange's method and Newton's method to determine frequencies and mode shapes | Flipped Class | 1707.4 | Class Quiz<br>End Term |
| 30 | Dynamic vibration absorber | Explain general about absorbers and their application | Flipped Class | 1707.5 | Class Quiz<br>End Term |
| 31 | Centrifugal pendulum absorber | Able to understand difference between various absorbers | Flipped Class | 1707.5 | Class Quiz<br>End term |
| 32-33 | Influence coefficient method for MDOF | Explain about influence coefficients and their importance | Flipped Class | 1707.5 | Class Quiz |
| 34 | Natural frequency and mode shape (Eigen Values and Eigen Vectors) | Explain concepts of Eigen value method to determine natural frequencies | Lecture | 1707.5 | Class Quiz<br>Mid Term II<br>End Term |
| 35-36 | Problems based on MDOF | Apply concepts of Eigen value method to plot mode shapes | Flipped Classroom | 1707.5<br>1707.3 | Class Quiz<br>Mid Term II<br>End Term |
| 37 | Torsional vibration (Single Rotor and Two rotor system) | Explain torsional vibration and why it happens | Flipped Classroom | 1707.5<br>1707.3 | Class Quiz<br>End Term |
| 38 | Torsionally equivalent shaft and torsional vibration of geared system | Describe how to make equivalent system | Flipped Classroom | 1707.5<br>1707.3 | Class Quiz<br>End Term |
| 39 | Problems based on torsional vibration | Determine of natural frequencies and mode shapes for SDOF and Two DoF | Lecture | 1707.1 | Class Quiz<br>End Term |
| 40 | Torsional vibration of three rotor system | Describe 3 DOF rotor system | Flipped Classroom | 1707.1 | Class Quiz<br>End Term |
| 41-42 | Holzer's method for multi rotor system | Explain Holzer's method and its usefulness in find out natural frequencies for torsional ssytem | Flipped Classroom | 1707.1 | Class Quiz<br>End Term |
| 43 | Problems based on multi rotor system | Able to apply Holzer's method | Flipped Classroom | 1707.1 | Class Quiz<br>End Term |
| 44 | Matrix Iteration method | Explain Matrix iteration Method to solve MDOF system | Lecture | 1707.4 | End Term |
| 45 | Problems based on matrix iteration method | Apply Matrix Iteration method to find response of MDOF | Lab Sessions | 1707.4 | End Term Theory |

| | | | | | |
|---|---|---|---|---|---|
| 46 | Rayleigh's method for lumped mass system | Difference between lumped and continuous mass system and explain Rayleigh's method | Lecture | 1707.5 | End Term |
| 47 | Rayleigh's method for distributed mass system | Explain various distributed mass system | Lecture | 1707.5 | Class Quiz<br>End Term |
| 48 | Problems based on Rayleigh's Method | Able to apply Rayleigh's method | Lecture | 1707.5 | Class Quiz<br>End Term |
| 49 | Dunkerley's method | Explain Dunkerley's method for Transverse Vibration | Lecture | 1707.5 | Class Quiz<br>End Term |
| 50 | Problems based on Dunkerley's method | Apply Dunkerley's method | Lecture | 1707.5 | Class Quiz<br>End Term |
| 51 | Whirling of shafts | Explain phenomena of whirling of shaft | Lecture | 1707.5 | Class Quiz<br>End Term |
| 52 | Problems based on whirling of shafts | Determination of critical speed of shaft to avoid resonance | Lecture | 1707.5 | Class Quiz<br>End Term |
| 53 | Transverse vibration of a string or cable | Explain formulation of governing equation of string or cable | Lecture | 1707.5 | Class Quiz<br>End Term |
| 54-56 | Longitudinal vibration of bar or rod | Explain formulation of governing equation of bar or rod | Lecture | 1707.5 | Class Quiz<br>End Term |

## H. 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 |
| ME 1707.1 | Describe and identify causes and effects of vibration in mechanical systems | | 1 | | | | | | | | | | | | | |
| ME 1707.2 | Construct linear vibratory models of different dynamic systems (e.g. linear and torsional) with different complexities like SDOF, MDOF | 3 | 2 | | | | | | | | | | | 2 | | |
| ME 1707.3 | Develop the differential equation of motion of vibratory systems using different approaches and solve the equations to get modes and mode shapes | 3 | | | | | | | | | | | | | | |
| ME 1707.4 | Analyse of free and forced (harmonic, periodic) vibration for single and multi-degree using different methods | | | | 2 | 1 | | | | | | | | 3 | | |
| ME 1707.5 | Develop skills for mathematical modelling of lumped and continuous systems using MATLAB (e.g. string and rod) | 3 | | | | | | | | | | | | | | |

**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

Computer Integrated Manufacturing | ME1708 | 3 Credits | 3 0 0 3

Session: July 2020 – Dec 2020 | Faculty: Mr G S S Adithya, Dr Ashish Goyal, Mr Shyam Sunder Sharma | Class: B. Tech. VII Sem

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering for 7th Semester students, targeting students who wish to pursue research & development in industries or higher studies in field of Mechanical Engineering, including controlling of advanced machine tools. Offers in-depth knowledge in CNC machines, and other parameters effect the production in a manufacturing industry, Students are expected to have a background knowledge on basic machine tools for better learning

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

**[ME 1708.1]** Prepare CNC part programs for enhanced programming skills for machining operations.

**[ME 1708.2]** Describe scope of C.I.M. in manufacturing industries

**[ME 1708.3]** Describe scope of group technology & MRP for better employability in manufacturing industries.

**[ME 1708.4]** Prepare CAPP (Computer Aided Process Planning) for manufacturing industries.

**[ME 1708.5**] Describe Flexible manufacturing System & automated inspection system for manufacturing 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.

**PROGRAMME SPECIFIC OUTCOMES:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I | 15 |
| | Sessional Exam II | 15 |
| | In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| 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

Introduction to NC machines, DNC Machine, CNC Machine, Part Programming, Maintenance, Economics of machining using CNC machines. Introduction to Computer Integrated Manufacturing Systems [CIMS]: Components, Types of Manufacturing Systems, Group Technology: Classification and Coding Systems. Computer Aided Process Planning: Rotational and prismatic parts, Material Requirement Planning [MRP], Manufacturing Resource Planning [MRP II], Capacity planning, Shop Floor Control, Introduction to FMS: AGV, AS/RS, Co-ordinate Measuring Machines [CMM], Universal Measuring Machine [UMM].

## F. TEXT BOOKS

T1. K. Yoram, *Computer Control of Manufacturing Systems and Computer Integrated Manufacturing*, McGraw Hill Education, 1983.

T2. M.P. Grover, *Automation, Production Systems, and computer Integrated manufacturing*, Pearson International Edition, 3rd Edition, 2008.

## G. REFERENCE BOOKS

R1. K. Yoram, Ben and U. Joseph, *Numerical Control of Machine Tools*, Khanna Publishers, 2005.

R2. P. Radhakrishnan, *Computer Numerical Control Machines*, New Academic Science Ltd., 2nd Edition, 2014.

## H. LECTURE PLAN

| Lecture | Topic | Session Outcome | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| **L1** | Introduction to NC,CNC & DNC, development in machine tools & basic components of NC | Students to know the development of machine tools | Lecture/PPT | **[ME1708.1]** | Mid-Term<br>1 Quiz |

| | | | | | |
|---|---|---|---|---|---|
| **L2** | Control Unit | To know various control units used in NC/CNC | Lecture/PPT | **[ME1708.1]** | Mid-Term 1<br>Quiz |
| **L3** | Application, Advantages and Disadvantages of NC/CNC/DNC | To know applications, merits & demerits of NC/CNC | Lecture/PPT | **[ME1708.1]** | Quiz |
| **L4** | Classification of NC/CNC based on feedback control & feedback devices | To know various feedback devices used in CNC | Lecture/PPT | **[ME1708.1]** | Mid-Term<br>1 Quiz |
| **L5** | Classification of NC/CNC based on motion control & Co- ordinate system | Students are able to know movement of cutting tool & coordinate system | Lecture/PPT | **[ME1708.1]** | Assignment |
| **L6** | Numerical control procedure, Part programming, type of dimensions, Programing format | To know various part programming formats | Lecture/PPT | **[ME1708.1]** | Mid-Term<br>1 Quiz<br>End term Exam |
| **L7** | G codes & M codes, Method of writing part programming, | To know various functions of G & M codes | Lecture/PPT | **[ME1708.1]** | Mid-Term 1<br>End term<br>Exam |
| **L8** | Part Programming for point to point machining | Prepare drilling part programming | Lecture/PPT | **[ME1708.1]** | Quiz<br>End term Exam |
| **L9** | Part Programming for machining along straight line | Prepare milling & lathe part programming | Lecture/PPT | **[ME1708.1]** | Mid-Term 1<br>End term Exam |
| **L10** | Part Programming for machining curved surface | Prepare milling & lathe part programming | Lecture/PPT | **[ME1708.1]** | Mid-Term 1<br>End term Exam |
| **L11** | Advanced part programming | Students are able to prepare complex part programming | Lecture/PPT | **[ME1708.1]** | Mid-Term<br>1 Quiz<br>End term Exam |

| | | | | | |
|---|---|---|---|---|---|
| **L12** | Advanced part programming | Students are able to prepare complex part programming | Lecture/PPT | **[ME1708. 1]** | Mid-Term<br>1 Quiz<br>End term Exam |
| **L13** | Economics of machining using CNC machines | Students are able to calculate CNC machining cost | Lecture/PPT | **[ME1708.1]** | Mid-Term<br>1 Quiz<br>End term Exam |
| **L14** | Historical perspective of CIM, Definitions of CIM | Learn about fundamentals of CIM | Lecture/PPT | **[ME1708.2]** | Mid-Term<br>1 Quiz<br>End term Exam |
| **L15** | Elements of CIM, CIM wheel | Students will enhance the knowledge of CIM | Lecture/PPT | **[ME1708.2]** | Mid-Term<br>1 Quiz<br>End term Exam |
| **L16** | Benefits of CIM, Factories of future and role of human labour in manufacturing system | To know about future of CIM | Lecture/PPT | **[ME1708.2]** | Mid-Term<br>1 Quiz<br>End term Exam |
| **L17** | Introduction of GT, Advantages & disadvantages of GT | Understand various features of GT | Lecture/PPT | **[ME1708.3]** | Quiz<br>End term Exam |
| **L18** | Production flow analysis (Numerical) | To know product flow | Lecture/PPT | **[ME1708.3]** | Quiz<br>&<br>Assignment<br>End term<br>Exam |

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|---|---|---|---|---|---|
| **L19** | Part classification and coding, Optize coding system | To know coding system | Lecture/PPT | **[ME1708.3]** | Mid-Term 2<br>End term<br>Exam |
| **L20** | MICLASS, CODE System | To know coding system | Lecture/PPT | **[ME1708.3]** | Mid-Term 2<br>End term<br>Exam |
| **L21** | Cellular manufacturing | Students will enhance the knowledge of CM | Lecture/PPT | **[ME1708.3]** | Quiz<br>End term Exam |
| **L22** | Introduction to CAPP | Learn about CAPP | Lecture/PPT | **[ME1708.4]** | Mid-Term 2<br>End term<br>Exam |
| **L23** | CAPP systems, Retrieval type CAPP, Generative type CAPP | Learn types of CAPP | Lecture/PPT | **[ME1708.4]** | Mid-Term 2<br>End term<br>Exam |
| **L24** | Case study 1 & 2 | To discuss manufacturing case study | Lecture/PPT | **[ME1708.4]** | Mid-Term 2<br>End term<br>Exam |
| **L25** | Introduction to MRP, MRP inputs, Output reports | Discuss MRP | Lecture/PPT | **[ME1708.3]** | Assignment & Discussion<br>End term Exam |
| **L26** | BOM, MRP calculations (numerical) | Calculate materials required | Lecture/PPT | **[ME1708.3]** | Mid-Term Quiz<br>End term |

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|---|---|---|---|---|---|
| | | | | | Exam |
| **L27** | MRP numerical | Calculate materials required | Lecture/PPT | **[ME1708.3]** | Mid-8erm 2 End t8r m Exam8 |
| **L28** | MRP II | To know various manufacturing resources | Lecture/PPT | **[ME1708.3]** | Mid-8erm 2 Quiz End Term Exam |
| **L29** | Capacity requirement planning | Students are able to calculate capacity of plant | Lecture/PPT | **[ME1708.3]** | Quiz End term Exam |
| **L30** | Shop floor control | To know the shop floor control ability | Lecture/PPT | **[ME1708.3]** | Assignment & Discussion End term Exam |
| **L31** | Building blocks of FMS | To gain knowledge of automatic manufacturing | Lecture/PPT | **[ME1708.5]** | Mid-Term 2 Quiz End term Exam |
| **L32** | Machining systems of FMS, Tool management systems | To know various tools of FMS | Lecture/PPT | **[ME1708.5]** | Mid-Term 2 Quiz End term Exam |

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|---|---|---|---|---|---|
| **L33** | Workpiece handling system, FMS control | Knowledge of various material handling Equipment | Lecture/PPT | **[ME1708.5]** | Mid-Term Quiz End term Exam |
| | | | | | |
| **L34** | Advantages of FMS, AGV | Students are able to know the advantages of automation | Lecture/PPT | **[ME1708.5]** | Mid-Term 2 End term Exam |
| **L35** | AS/RS | To know automatic storage & retrieval system | Lecture/PPT | **[ME1708.5]** | Mid-Term 2 Quiz End term Exam |
| **L36** | Contact inspection methods & non-contact inspection methods | To know various techniques used for automatic inspection | Lecture/PPT | **[ME1708.5]** | Mid-Term 2 End term Exam |
| **L37** | Machine vision, Scanning laser beam | To know non-contact inspection methods | Lecture/PPT | **[ME1708.5]** | Mid-Term 2 Quiz End term Exam |
| **L38** | Coordinate measuring machine (CMM) | To know reverse engineering tool | Lecture/PPT | **[ME1708.5]** | Mid-Term 2 End term Exam |
| **L39** | Universal measuring machine (UMM) | To know reverse engineering tool | Lecture/PPT | **[ME1708.5]** | Mid-Term 2 |

## 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 |
| **[ME 1708. 1]** | Prepare CNC part programs for enhanced programming skills for machining operations. | 3 | | | | 2 | | | | | | | | | | 1 |
| **[ME 1708. 2]** | Describe scope of C.I.M. in manufacturing industries | 3 | | 2 | | 2 | | | | | | | | 2 | | |
| **[ME 1708. 3]** | Describe scope of group technology & MRP for better employability in manufacturing industries. | 3 | | | | 2 | | | | | | | | | | |
| **[ME 1708. 4]** | Prepare CAPP (Computer Aided Process Planning) for manufacturing industries. | 3 | | | | 2 | | | | | | | | | | |
| **[ME 1708. 5]** | Describe Flexible manufacturing System & automated inspection system for manufacturing Industries | 3 | | 2 | | 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

Computer Aided Design| ME 1709 | 3 Credits | 3 0 0 3

Session: Odd Semester 2020-21 | Faculty: Dr. Ravi Kumar Gupta/ Dr. Santosh Patil/Dr Anwesa Barman |

Class: B.Tech Sem. VII; Dept. Core

**A. Introduction:** Computer aided design is widely used in industry for analysing and modelling structures and creating solutions for various problems at a faster and efficient ways. CAD is particularly useful for engineering designs that are too complicated to be solved by conventional designing process. The brief contents of the course include Introduction to CAD, CAD tools, Hardware and software for CAD, mathematical representation of curves, surface and solids, synthetic surfaces, solid modelling.

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

[1709.1] Describe the design process and basic CAD practices for engineering design and drawing.

[1709.2] Evaluate the CAD transformations and curve fitting.

[1709.3] Illustrate the core concepts of computer graphics in Computer-Aided Design.

[1709.4] Represent the Skill of designing and evaluation of parametric cubic, Bezier, B-spline curves and surfaces and solids.

[1709.5] Possess a good understanding of solid modelling for employability in product design.

**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.

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**D. Assessment Rubrics:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | In class Quizzes and Assignments, Activity feedbacks (Accumulated and Averaged) | 30 |
| End Term Exam (Summative) | End Term Exam (Open 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**

Introduction to CAD, Geometric transformation techniques, Representation of curves, curve fitting techniques, Cubic curves, Beziers and b-splines, Hermite curve, Rational curves\NURBS. Types and representation of surfaces, Analytic surfaces, Synthetic types, Polygon surfaces, Quadric and super quadric surface, Bezier and B-spline surface, Hermite surface, Coon's surface, Blobby objects. Solid Modeling: Constructive solid geometry, Boundary representation, CAD standards, Graphical kernel system (GKS), Data exchange standards for modelling data.

**F. Text Books**

T1. I.K. Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill New Delhi, 1998.

T2. D.F.Rogers and J Alan Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill New Delhi, 2002.

**G. Reference Books**

R1.D.F.Rogers and J A Adams, Procedural Elements for Computer Graphics, McGraw

**H. Lecture Plan:**

| Lec No | **Topics** | **Session Outcome** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| L1–L2 | Introduction to CAD, benefits and application | To understand the basics of Computer Aided Design and product life cycle | Lecture | 1709.1 | In Class Quiz (Not Accounted) |
| L3 | Conventional and CAD comparisons | Debate on the conventional and CAD practices | Flipped Classroom | 1709.1 | In Class Quiz |
| L4–L5 | Design Process, CAD software systems, input and output devices, Data Exchange | Identify different design process, CAD systems and computer devices | Lecture | 1709.1 | In Class Quiz<br>Mid Term I<br>End Term |
| L6 – L7 | Geometric transformation techniques, translation, rotation, scaling | Explain different transformation procedures and formulations | Lecture | 1709.2 | Home Assignment<br>Mid Term I<br>End Term |
| L8 | Problems based on translation, rotation and scaling, Quiz 1 | Employ translation, rotation and scaling transformations and solve | Lecture | 1709.2 | In Class Quiz<br>End Term |
| L9 | Reflection and shearing, | Employ reflection and shearing transformations and solve | Lecture | 1709.2 | Class Quiz<br>Mid Term I<br>End Term |
| L10 – L11 | Problem based on 2D and 3D transformation technique | Employ different transformations and solve | Self-Study | 1709.2 | Home Assignment<br>Class Quiz<br>Mid Term I<br>End term |
| L12 | Problem based on 2D and 3D transformation technique continued. | Employ different transformations and solve | Self-Study | 1709.2 | Class Quiz<br>Mid Term I<br>End Term |
| L13 | Quiz 2 and Assignment – 1 and 2 | Recall the CAD basics and solve transformation problems | Quiz | 1709.1<br>1709.2 | Class Quiz<br>Mid Term I<br>End Term |
| L14 – L15 | Curve Fitting- Polynomial approximation and Problems | Describe the Curve fitting techniques | Lecture | 1709.3 | Class Quiz<br>Mid Term I<br>End Term |
| L16 – L17 | Method of Least Squares and Problems | Describe least square curve fitting method and employ it | Lecture | 1709.3 | Class Quiz<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| L18 | Matrix Formulation of Least Square Methods and Problems | Employ least square method and matrix formulation | Lecture, solving problems | 1709.3 | Home Assignment<br>Class Quiz<br>Mid Term I<br>End Term |
| L19 | Weighted Least Square Method | Describe other different least square curve fitting techniques | Lecture, solving problems | 1709.3 | Class Quiz<br>Mid Term I<br>End Term |
| L20 – L22 | Exponential function curve fitting and Parametric representation of synthetic curves- Blending functions | Describe exponential curve fitting techniques and curve representation | Lecture | 1709.2<br>1709.3 | Class Quiz<br>Mid Term II<br>End Term |
| L23 – L24 | Cubic spline, Bezier and B-spline Curves and Problems | Describe curve representation forms and formulations | Lecture | 1709.4 | Home Assignment<br>Class Quiz<br>Mid Term II<br>End Term |
| L25 | Quiz 3 and Assignment – 3 and 4 | Recall the curve fitting and curve representation techniques | Quiz | 1709.4 | Class Quiz |
| L26 – L27 | Hermite curves, Comparison between all types of curves | Compare different types of curve representation forms | Flipped Class | 1709.4 | Class Quiz<br>Mid Term II<br>End Term |
| L28 | Curve manipulation – Design and application | Describe curve formulation and manipulation | Flipped Class | 1709.4 | Class Quiz<br>End Term |
| L29 – L30 | Representation of 3D graphics surfaces and Super quadric surfaces | Describe surface representation forms and formulations | Flipped Class | 1709.3 | Home Assignment<br>Class Quiz<br>Mid Term II<br>End Term |
| L31– L32 | Bezier, B-spline Surfaces, Hermite Surfaces | Describe synthetic surface representation forms and formulations | Flipped Class | 1709.4 | Home Assignment<br>Class Quiz<br>Mid Term II<br>End Term |
| L33 | Quiz 4 and Assignment – 5 and 6 | Describe the synthetic surface representation techniques | Quiz | 1709.3<br>1709.4 | Class Quiz<br>End term |
| L34 – L35 | Offset, Plane and Ruled surfaces | Describe the plane surface representation techniques | Flipped Class | 1709.4 | Class Quiz<br>Mid Term II |
| L36 | Tabulated cylinder and rational parametric surface | Describe the parametric surface representation techniques | Lecture | 1709.4 | Class Quiz<br>End Term |
| L37 | COON's surface and surface manipulation | Describe the COON's surface representation techniques | Flipped Classroom | 1709.4 | Class Quiz<br>End Term |
| L38 – L39 | Representation of Solid model and entities, B-rep and CSG | Describe the solid representation techniques | Flipped Classroom | 1709.5 | Class Quiz<br>End Term |

| | | | | | |
|---|---|---|---|---|---|
| L40 – L42 | Sweep representation and analytical solid modelling and Feature based modelling, Quiz 5, Assignment 7 | Analyze the solid representation techniques | Flipped Classroom | 1709.5 | Class Quiz<br>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 |
| ME 1709.1 | Describe the design process and basic CAD practices for engineering design and drawing. | 2 | | | | | | | | | | | 1 | 2 | | |
| ME 1709.2 | Evaluate the CAD transformations and curve fitting. | 2 | 3 | | | | | | | | | | | 1 | | |
| ME 1709.3 | Illustrate the core concepts of computer graphics in Computer-Aided Design. | 2 | | 1 | | | | | | | | | | | | |
| ME 1709.4 | Represent the Skill of designing and evaluation of parametric cubic, Bezier, B-spline curves and surfaces and solids. | 3 | | | 1 | | | | | | | | | 2 | | |
| ME 1709.5 | Possess a good understanding of solid modelling for employability in product design. | | | 1 | 2 | | | | | | | | 3 | 2 | | |

# MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

Mechanical Vibration Lab| ME 1732 | 1 Credits | 0 0 2 1

Session: Aug 20 – Dec 20 | Faculty: Dr. Dhaneshwar Mishra/ Dr. Abhishek Sharma/Dr. Ashish Sharma/

Dr Anwesa Barman/ Mr Arpit Khandelwal | Class: B.Tech VII Sem

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering as compulsory course for 7th semester students as a lab. This lab course gives students hands on experience to understand the basic concept of subject. Students could able to analyse the source of vibration and effect on mechanical system. They would also understand how free and forced vibration system works and how damping effects the response of system. Students will acquired the skill of how to balance the unbalance forces in the system.

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

**[1732.1]** Analyse of parameters effecting the time period of Single and two degree freedom system.

**[1732.2]** Understanding of the concept of compound pendulum and bifilar suspension to measure the mass moment inertia of any shape object.

**[1732.3]** Analysis of effect of damping over response of mechanical system.

**[1732.4]** Practical understanding of free and forced vibration systems.

**[1732.5]** Develop the skill to measure the whirling speed of shaft and balancing of rotating mass 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, 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

**Programme Specific Outcomes**

**[PSO.1].** Model and analyse of Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Laboratory Sessions | 60 |
| End Term Assesment (Summative) | Lab Exam Performance | 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 Practical End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. | |
| Make up Assignments (Formative) | Students who misses a lab session will have to report to the teacher about the absence. The missed experiment can be performed as a makeup experiment in the next lab session or anytime before the laboratory exam | |
| Laboratory Guidelines | Students are expected to maintain an observation book and a laboratory record notebook. The experimental data should be noted in the observation book on the day of performance and the same should be transferred to the record notebook before the next lab. No students are allowed to enter the lab without the observation book and record book and attendance will be marked absent | |

## E. Syllabus

Simple and compound pendulum, Bifilar suspension, Undamped longitudinal free vibration of a spring, Torsional undamped and damped free vibration, Damped Forced vibration, Transverse vibration of beam and Whirling of shaft, Static and dynamic balancing of rotary masses

**Reference Books**

1. S.S.Rao, Mechanical Vibration, Pearson Education, Delhi, 6th Edition

2. G.K. Groover, Mechanical Vibration, Nem Chand & Bros, 8th edition

**A. Lecture Plan:**

| Lab No | Name of the Experiment | Experiment Outcome | Type of Expt | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introduction and Laboratory briefing | To acquaint and clear teachers expectations and understand student expectations | Live Demo | NA | NA |
| 2 | To study the oscillations of simple pendulum | To know what are the parameters affect time period of simple pendulum | Hands On | **1732.1** | Observational Data, Viva-Voce |
| 3 | To study the oscillation of the compound pendulum | Able to calculate radius of gyration of any physical body using the concept of compound pendulum | Hands On | **1732.2** | Observational Data, Viva-Voce |
| 4 | To study un-damped torsional vibrations of the single rotor system | Acquaint with torsional vibration and to know how to calculate time period | Hands On | **1732.1** | Observational Data, Viva-Voce |
| 5 | To study damped torsional vibration of single rotor system. | Able to analyse the effect of viscous damping on system and calculate damping parameters | Hands On | **1732.3** | Observational Data, Viva-Voce |
| 6 | To study the torsional vibration of two rotor system | Acquaint with torsional vibration of two degree of freedom system and to know how to calculate time period | Hands On | **1732.1** | Observational Data, Viva-Voce |
| 7 | To study undamped free vibration of spring. | Able to analysis effect of different mass on time period of system | Hands On | **1732.1** | Observational Data, Viva-Voce |
| 8 | To study natural vibration of a spring mass system | Able to develop mathematical model of continuous system and calculate time period | Hands On | **1732.1** | Observational Data, Viva-Voce |
| 9 | To study forced damped vibrations of spring mass system | Able to analyse the effect of unbalance forces on system and why damping is important in mechanical system | Hands On | **1732.4** | Observational Data, Viva-Voce |

| | | | | | |
|---|---|---|---|---|---|
| 10 | Static balancing of rotating mass system | Able to calculate unbalance of masses and how to balance system statically | Hands On | **1732.5** | Observational Data, Viva-Voce |
| 11 | Dynamic balancing of rotating mass system | Acquaint with balancing of rotating mass system completely by placing the masses radial and angular balancing positions. Also familiar with how a small amount of unbalance can create large amount of vibration | Hands On | **1732.5** | Observational Data, Viva-Voce |
| 12 | To verify Dunkerley's rule for transverse vibrations | Develop skill how to calculate the natural frequency of transverse vibration system with number of masses | Hands On | **1732.1** | Observational Data, Viva-Voce |
| 13 | To determine the radius of gyration of a body using bi-filler suspension | Acquire skill how to calculate moment of inertia of irregular geometries | Hands On | **1732.2** | Observational Data, Viva-Voce |
| 14 | To study Whirling speed of shaft | Understand the concept of critical/whirling speed of shaft and calculate working speed range of system | Hands On | **1732.5** | Observational Data, Viva-Voce |

**B. 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 |
| 1732.1 | Analyse of parameters effecting the time period of Single and two degree freedom system. | 3 | 2 | | | | | | | | | | | 3 | | |
| 1732.2 | Understanding of the concept of compound pendulum and bifilar suspension to measure the mass moment inertia of any shape object. | 3 | 3 | | | | | | | | | | | 1 | | |
| 1732.3 | Analysis of effect of damping over response of mechanical system. | 2 | 2 | | 1 | | | | | | | | | 2 | | |
| 1732.4 | Practical understanding of free and forced vibration systems. | 1 | | | 1 | | | | | | | | 1 | 1 | | |
| 1732.5 | Develop the skill to measure the whirling speed of shaft and balancing of rotating mass systems | 3 | 2 | | | | | | | | | | 1 | 1 | | |

**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

RAC Lab | ME 1733 | 1 Credits | 0 0 2 1

Session: Jul 20 – Dec 20 | Faculty : Hemant Raj Singh/Rahul Khatri | Class: VII Semester

**A. Introduction:** In this lab we aimed to make the students familiar with the practical application of thermodynamics in the field of refrigeration and air conditioning. Students will carry out the performance assessments of various refrigeration and air conditioning systems.

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

[1733.1] Understand and visualize the working of refrigeration systems.
[1733.2] Applications of concepts and defining the performance of refrigeration systems.
[1733.3] Understand and visualize the working air conditioning systems and determining their performances
[1733.4] Applications of concepts in air conditioning systems and determining their performances.

**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.

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**D. Assessment Rubrics:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment | Lab Experiments and Viva | 60 % |
| End Term Exam | End semester examination | 40 % |
| | 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. | |

**E. List of Experiment**

1. To study refrigeration cycle, coefficient of performance of cycle & tonnage capacity of Refrigeration and Air Conditioning unit
2. To study the basic components of simple vapour compression refrigeration cycle. i.e. compressor, condenser, expansion valve, and evaporator
3. To study the various types of Vapour compression cycle with T-s and P-h diagram
4. To find COP and Tonnage capacity of Vapour Compression Refrigeration Test Rig
5. To find performance of various types of expansion devices on Vapour Compression Refrigeration test Rig
6. To study various components of Room Air Conditioning system
7. To determine COP and Tonnage capacity of Air Conditioning Trainer
8. To study and determine effectiveness of Cooling Tower
9. To study and determine performance of Vapor Absorption Refrigeration system
10. To study and determine effectiveness of Evaporative Cooler
11. To study different psychrometric process & chart

| 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 |
| [1733.1] | Understand and visualize the working of refrigeration systems. | 3 | | | | | | | | | | | | | | |
| [1733.2] | Applications of concepts and defining the performance of refrigeration systems. | 3 | 2 | | 2 | | 1 | 1 | | | | | 2 | | 1 | |
| [1733.3] | Understand and visualize the working air conditioning systems and determining their performances | 3 | | | | | | | | | | | | | | |
| [1733.4] | Applications of concepts in air conditioning systems and determining their performances. | 3 | 2 | | 2 | | 1 | 1 | | | | | 2 | | 1 | |

**MANIAPL UNIVERSITY JAIPUR**
School of Automobile, Mechanical and Mechatronics

**DEPARTMENT OF MECHANICAL ENGINEERING**

Course Hand-out

Computer Aided Design Lab | ME1734 | 1 Credits | 0 0 2 1

Session: Odd Semester 2020-21 | Faculty: Mr. Rakesh Kumar | Class: B.Tech VII Sem

A. **Introduction:** This course is offered by Dept. of Mechanical Engineering, targeting students who wish to pursue research& development in industries or higher studies in field of Mechanical engineering as a design specialist. In this course, it is aimed to provide students with the CAD, CAE and CAM tools usages in the product development.

## B. Course Outcomes:

**[ME1734.1].** Students are capable of developing 2D and 3D models of machine components, complex geometries etc. using CATIA V6

**[ME1734.2].** Students are capable to generate 2D sketches of the assembled parts and provide dimensions and symbols to generate 2D drawing.

**[ME1734.3].** Students can apply their knowledge in importing CAD geometries and to modify and mesh using different meshing methods and local meshing controls as a part of preprocessing of the FE problem in ANSYS workbench

**[ME1734.4].** Apply product development using CATIA, ANSYS and CAM tools.

## 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.

**Programme Specific Outcomes:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Lab work and Assignments | 60 % |
| End Term Exam (Summative) | End semester examination | 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

Introduction to design process and modeling using CATIA, Sketcher, Part design, Dimensioning and notes. Assembly drawings with sectioning and bill of materials. Finite Element Analysis using ANSYS 2D spur 2D beam element, 2D solid element, 2D thermal element, Shell element, 3D sold element. CNC turning, CNC milling.

## F. Text Books:

1. S. Tickoo, *CATIA V5-6R2016 for Designers*, BPB Publications, 14th Edition 2017.
2. Lab manual for CNC turning, CNC milling.

## G. References:

1. Online manuals for CATIA and ANSYS

**H. Lecture Plan:**

| Lab No | **Name of the Experiment** | **Experiment Outcome** | **Type of Expt** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| L1 | Introduction to sketcher workbench to draw 2D geometries- Standard tool bar, profile tool bar, view tool bar, sketch tool bar, constraint tool bar, Introduction to Part design workbench- Sketch based features toolbar | Students will be able to apply principles of engineering sciences to generate 2D sketches and analyse for a better design of machine components and systems. | Hands on | CO1 | Student lab practice |
| L2, L3 | Part design workbench- Dress up feature tool bar, Transformation feature tool bar, Measure, surface-based feature tool bar, Drafting | Students will be capable to effectively communicate about the 3D models design | Hands on | CO1 and CO2 | Student lab practice on given problem |
| L4 | Practise Exercise on part design | 2D and 3D Modelling in CATIA | Hands on | CO1 | Student lab practice |
| L5 | Demonstration and practise exercise on Assembly | Students will be able to apply fundamental engineering knowledge in the design, modelling and assembly of machine components | Hands on | CO2 | Student lab practice |
| L6 | Assignment problems | 2D and 3D Modelling in CATIA | Hands on | CO1, CO2 and CO4 | University Exam |
| L7 | Introduction to ANSYS workbench- static structural solver- | Students will be capable of conducting analysis using modern tools like ANSYS | Hands on | CO3 | Student lab practice |

| | | | | | |
|---|---|---|---|---|---|
| L8 | Meshing Methods – Local meshing tools | Students will be capable of conducting analysis using modern tools like ANSYS | Hands on | CO3 | Student lab practice |
| L9 | Exercise for ANSYS (Beam-2 problem) | Students will be capable of conducting Static structural analysis | Hands on | CO3 and CO4 | Student lab practice |
| L10 | Exercise for ANSYS 2 (Stepped Bar 1 problem, Truss 2 problem) | Students will be capable of conducting Static structural analysis | Hands on | CO3 and CO4 | Student lab practice |
| L11 | Exercise for ANSYS 3 (3D model) | Students will be capable of conducting Static structural analysis | Hands on | CO3 and CO4 | Student lab practice |
| L12 | Introduction to G and M codes for CNC milling and drilling | Students will be able to understand CNC programming codes | Demonstration | CO4 | Viva-Voce |
| L13 | Demonstration on CNC Milling machine | Students will be capable of conducting CNC milling | Live demo | CO4 | Observational Data, Viva-Voce |

## I. 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 |
| [ME1734.1] | Students are capable of developing 2D and 3D models of machine components, complex geometries etc. using CATIA V6 | 2 | | 1 | | 1 | | | | | 2 | | 1 | 2 | | |
| [ME1734.2] | Students are capable to generate 2D sketches of the assembled parts and provide dimensions and symbols to generate 2D drawing. | 2 | 2 | 1 | | | | | | | 1 | | 1 | 2 | | |
| [ME1734.3] | Students can apply their knowledge in importing CAD geometries and to modify and mesh using different meshing methods and local meshing controls as a part of pre-processing of the FE problem in ANSYS workbench. | 3 | 2 | 2 | | 1 | | | | | 2 | | 2 | 2 | | |
| [ME1734.4] | Apply product development using CATIA, ANSYS and CAM tools. | 2 | 2 | 1 | | 2 | | | | | 2 | | 2 | 3 | | |

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

Power Plant Engineering | ME1757 | 3 Credits | 3 0 0 3

Session: Jul 20 – Nov 20 | Faculty: Mr. Hemant Raj Singh | Class: Final Year (Program Elective)

**A. Introduction:** In the present scenario world is facing prolonged energy crisis. To overcome this crisis, the design of efficient power stations is very important for mechanical engineering students. Power plant engineering course provides good understanding and working of different types of power plants. This course is an elective course designed for students of mechanical engineering discipline to acquire quality knowledge in the area of power generation. Prior knowledge of vapour-power cycle, Otto cycle, diesel cycle has been implemented to study different types of power generation plants viz. steam power plant, diesel power plant, gas power plant, nuclear power plant, and hydro power plant. Site selection and economics of power plant has also been incorporated in the course for comprehensive understanding of power plants.

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

**[ME1757.1]** Understand the basics of various types of power plants along with economic aspects, site selection, and environmental effects. *[Bloom's Level: Analysis]*

**[ME1757.2]** Describe working principle and various components of steam power plant. *[Bloom's Level: Comprehension]*

**[ME1757.3]** Explain the components and working of diesel and gas power plants. *[Bloom's Level: Comprehension]*

**[ME 1757.4]** Elaborate the details of nuclear power plant along with safety measures to increase employability. *[Bloom's Level: Comprehension]*

**[ME 1757.5]** Describe the classification and components of hydro-electric power plant. *[Bloom's Level: Comprehension]*

**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.

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

**D. Assessment Rubrics:**

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Closed Book) | 15 |
| | Sessional Exam II (Closed Book) | 15 |
| | Presentations | 30 |
| 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. | |
| Home Work (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 evaluated for internal assessment. | |

**E. Syllabus**

Steam power plant, Rankine cycle improvisation, Layout, Components and accessories, Steam and heat rate, Coal and ash handling systems, Draught system, Feed water system, Binary cycles and cogeneration systems. Diesel and Gas Turbine Plant: Otto, Diesel, Dual & Brayton Cycle - Analysis & optimization, Components, Combined cycle power plants. Nuclear Power Plants: Location, Component of nuclear plants, Types of reactors, Uranium enrichment, Safety, Disposal of nuclear waste, Comparison with thermal plants, Safety measures for

nuclear power plants. Hydro-electric power plant: Classification, components and auxiliaries. Major Hydro plants in India, Power plant economics: power tariff types, load distribution parameters, load curve, site selection, pollution control.

**F. Text Book:**

1. P. K. Nag, Power Plant Engg., Tata McGraw Hill Publishing Co Ltd.
2. R. K. Rajput, Power Plant Engineering, Laxmi Publications (P) Ltd.

**G. References:**

1. R. Yadav, Steam and Gas Turbines and Power Plant Engineering, Central Pub House-Allahabad.
2. G. R. Nagpal, Power Plant Engineering, Khanna Publishers.
3. M. M. Wakil, Power Plant Technology, McGraw Hill International.
4. NPTEL Video Lectures: Energy Resources & Technology.

**H. Lecture Plan:**

| Lec No | Topics | Session Outcomes | Mode of Delivery | Corresponding CO | Mode of Assessing the Outcome |
|---|---|---|---|---|---|
| 1 | Introduction to Power Plant Engineering. | Outline of the course. Know the basics of different types of power plants. | Lecture | ME1757.1 | Assignments, Class Quizzes, MTE-I, ETE. |
| 2 | Review of Thermo-dynamic cycles | Review of knowledge about thermodynamic cycles which are used in power plants. | Flipped Class | ME1757.1 | |
| 3 | Power plant economics: Introduction, Load-duration curves | Understand the terms and definitions related to power plant economies. | Lecture | ME1757.1 | |
| 4 | Power tariff types, Cost Analysis | Understand the power tariff management and apply cost analysis methods | Lecture, Activity | ME1757.1 | |
| 5 | Site selection | Understand the site selection criteria | Lecture | ME1757.1 | |
| 6 | Pollution and its control | Understand the environmental effects of power plants and contemplate on renewable energy / green energy options | Lecture, Activity | ME1757.1 | |
| 7 | Introduction to Steam Power Plant, Working Principle | Understand the working of a steam Power plant | Lecture | ME1757.1 ME1757.2 | |
| 8 | Improvement of Rankine cycle | Understand the improvisation criteria of basic Rankine cycle | Lecture | ME1757.2 | |
| 9 | General Layout, Coal Burning Methods | Understand the deciding criteria for layout of power plant along with methods of coal burning. | Lecture | ME1757.2 | |
| 10 | Coal and Ash handling systems | Understand the coal and ash handling systems in power plant | Lecture | ME1757.2 | |
| 11 | Chimney Draught, | Understand the functions of | Lecture, | ME1757.2 | |

| | | | | | |
|---|---|---|---|---|---|
| | Calculation of Chimney Height | chimney and apply the knowledge for calculation of chimney height | Activity | | |
| 12 | Boilers and accessories | Discuss various types of boilers and their accessories | Flipped Class | ME1757.2 | |
| 13 | Steam Turbines | Describe the working of steam turbines | Lecture | ME1757.2 | |
| 14-15 | Feed Water System, condensers | Describe feed water system and condensers. | Lecture | ME1757.2 | |
| 16 | Cooling towers | Understand the working of various types of cooling towers | Lecture | ME1757.2 | |
| 17 | Binary cycle and cogeneration systems | Describe the usage of binary cycle and cogeneration system for power generation | Flipped Class | ME1757.2 | |
| 18 | Introduction to Diesel Cycle Plant, General Layout of Diesel Cycle Plant and Plant Components | Understand the components and working of diesel power plant | Lecture | ME1757.1 ME1757.3 | Assignments, Class Quizzes, MTE-II, ETE. |
| 19 | DG Plant | Demonstrate the components and working of DG plant | Lab/Field Visit | ME1757.3 | |
| 20 | Introduction to Gas Turbine Plant, General Layout of Gas Turbine Plant and Plant Components | Understand the components and working of gas power plant | Lecture | ME1757.3 | |
| 21 | Combined cycle power plant | Analyze the usage of combined cycle for power generation | Flipped Class, Lecture | ME1757.3 | |
| 22 | Introduction to Nuclear Power Plant | Understand the basics of nuclear power plant | Lecture | ME1757.1 ME1757.4 | |
| 23 | Nuclear Plant Location, Different Nuclear Power Plant in India and Developing Countries | Contemplate the factors influencing the location of a nuclear power plant. | Flipped Class | ME1757.1 ME1757.4 | |
| 24-25 | Components of Nuclear Power Plant | Understand the various components of nuclear power plant | Lecture | ME1757.4 | |
| 26 | Reactors and their types | Describe the types and working of reactors used in nuclear power plant | Lecture | ME1757.4 | |
| 27 | Uranium enrichment, safety and disposal of nuclear waste | Explain the process of Uranium enrichment and Discuss the safety aspects for dealing with nuclear waste | Lecture | ME1757.4 | |
| 28 | Comparison of Nuclear and Thermal Power Plant | Analyze the differences between nuclear and thermal power plants with reference to energy source and working | Flipped Class, Activity | ME1757.2 ME1757.4 | |
| 29 | Safety measures for nuclear power plant | Identify the safety measures associated with nuclear power plant | Lecture | ME1757.4 | |

| | | | | | |
|---|---|---|---|---|---|
| 30 | Introduction and Classification of Hydro-electric Power Plant | Understand the basics of hydro-electric power plants | Lecture | ME1757.1<br>ME1757.5 | Assignments, Class Quizzes, ETE |
| 31-32 | Advantages and Disadvantages of water power, | Explain various characteristics of water as a power source | Lecture | ME1757.5 | |
| | optimization of hydro-thermal mix | | | | |
| 33 | Component and Auxiliaries of Hydro-electric Power Plant | Describe the components and auxiliaries used in the working of hydro power plant | Lecture | ME1757.5 | |
| 34 | Comparison of Hydro plant and Thermal Power Plant | Analyze the differences between hydro and thermal power plants with reference to energy source and working | Flipped Class, Activity | ME1757.2<br>ME1757.5 | |
| 35 | Major Power Plants in India | Identify and discuss various power plants located in India | Flipped Class, Activity | ME1757.1<br>ME1757.2<br>ME1757.3<br>ME1757.4<br>ME1757.5 | |
| 36 | Comparative review of power plants | Comparative analysis of various types of power plants with reference to available resources and environmental impacts | Activity | ME1757.1<br>ME1757.2<br>ME1757.3<br>ME1757.4<br>ME1757.5 | |

## 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 |
| ME1757.1 | Understand the basics of various types of power plants along with economic aspects, site selection and environmental effects | 2 | 2 | 3 | 2 | 1 | 3 | 3 | | | 1 | 2 | | 1 | | |
| ME1757.2 | Describe working principle and various components of steam power plant | 3 | 1 | | 1 | | | | | | | | | 1 | | |
| ME1757.3 | Explain the components and working of diesel and gas power plants | 3 | 1 | | 1 | | | | | | | | | 1 | 1 | |
| ME1757.4 | Elaborate the details of nuclear power plant along with safety measures | 3 | 1 | 1 | 1 | | 2 | 2 | | | | | | 1 | | |
| ME1757.5 | Describe the classification and components of hydro-electric power plant | 3 | 1 | | 1 | | | | | | | | | 1 | | |

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

## J. Course Outcome Attainment Level Matrix:

| CO | STATEMENT | ATTAINMENT OF PROGRAM OUTCOMES | | | | | | | | | | | | 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 |
| ME1757.1 | Understand the basics of various types of power plants along with economic aspects, site selection and environmental effects | | | | | | | | | | | | | | | |
| ME1757.2 | Describe working principle and various components of steam power plant | | | | | | | | | | | | | | | |
| ME1757.3 | Explain the components and working of diesel and gas power plants | | | | | | | | | | | | | | | |
| ME1757.4 | Elaborate the details of nuclear power plant along with safety measures | | | | | | | | | | | | | | | |
| ME1757.5 | Describe the classification and components of hydro-electric power plant | | | | | | | | | | | | | | | |

**0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment**

# MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

Renewable Energy Systems| ME 1758 | 4 Credits | 3 0 0 3

Session: July 20 – Dec. 20 | Faculty: **Dr. Ravi Kumar Sharma** | Class: B. Tech. IV Year

**A. Introduction:** Renewable energy sources derive their energy from existing flows of energy from ongoing natural processes, such as sunshine, wind, flowing water, biological processes, and geothermal heat flows. A general definition of renewable energy sources is that renewable energy is captured from an energy resource that is replaced rapidly by a natural process such as power generated from the sun or from the wind. Currently, the most promising (aka economically most feasible) alternative energy sources include wind power, solar power, and hydroelectric power. Other renewable sources include geothermal and ocean energies, as well as biomass and ethanol as renewable fuels. This subject also impart the knowledge of energy storage.

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

**[1758.1].** Analyse the main sources of energy and their primary applications in the INDIA, and the world.
**[1758.2].** Evaluate the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
**[1758.3].** Create remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources.
**[1758.4].** Select the primary renewable energy resources and technologies.
**[1758.5].** Develop the basic electrical concepts and system components related to renewable sources.
**[1758.6].** Thermal energy storage using appropriate 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 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.

**Programme Specific Outcomes**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | Online Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged) | 30 |
| 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. | |

## E. Syllabus

**Introduction:** Different forms, Sources, Need for renewable energy sources, **Solar energy**: Sun as source of energy, Solar air heaters, Cooking, Drying, Distillation, Space heating, Refrigeration, Power generation: Low, medium and high temperature cycle, **Solar radiation at the earth's surface:** Measurement of solar radiation, solar radiation geometry, **Wind power:** Total and maximum power ( Betz theory), Actual power, Types of windmill, Wind turbine operation, Forces on the blades and thrust on turbines, **Biomass:** Types of biomass, Biogas production from organic waste by an aerobic fermentation, **Conversion of energy**: Thermal, chemical and electromagnetic energy into electricity, **Energy Storage**: Different modes of energy storage, Phase change materials, Selection criteria of PCMs, classification of PCMs.

## F. Text Books

T1. S P Sukatme, Solar Energy Principles of Thermal Collection and Storage, Tata Mc Graw Hill, 2005.

T2. G. D. Rai, Non-conventional Energy Sources, Khanna Publications, 2011.

T3. H. P. Garg and J. Prakash, Solar Energy: Fundamentals and Applications, McGraw Hill Education, 2017.

## G. Reference Books

R1. S Rao and Dr. B B Parulekar, Energy Technology, Khanna Publishers, 2004.

R2. B H Khan, Non-conventional energy resources, Mc Graw Hill, 2017.

**H. Lecture Plan:**

| Lec No | **Topics** | **Session Outcomes** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1,2,3 | Introduction: Different forms of energy | Recall about the energy and their different types of conversion | Lecture | | NA |
| 4,5 | Sources of energy | Discuss about bases of energy from where get the individual one | Flipped Classroom | [1758.1] | Cross questioning in the class |
| 6,7 | Need for renewable energy sources | Justify the reason behind the need of alternate sources as well as renewable too | Activity (Think Pair Share) | [1758.1], [1758.2], [1758.3], [1758.7] | In Class Quiz |
| 8 | India's production and reserves of Commercial energy sources and potential of Renewable energy resources | Brief about the potential source of energy available | Lecture | [1758.1] [1758.2] [1758.3] [1758.6] | Home Assignment |
| 9,10 | Solar air heaters | Implementation of solar renewable energy | Lecture | [1758.4] | In Class Quiz |
| 11,12 | Cooking, Drying, Distillation, Space heating | Design technique to use the solar energy | Activity (Think Pair Share) | [1758.4] | Home Assignment |
| 13,14 | Refrigeration | Compare the conventional system with renewable use | Activity (Reciprocal teaching) | [1758.5] | Home Assignment |
| 15,16 | Power generation-low, medium and high temperature cycle | Identify the generation according to temperature range | Flipped Class | [1758.4] | Class Quiz |
| 17,18 | Solar radiation at the earth's surface: Measurement of solar radiation | Explain about the relation between solar radiation and earth location | Lecture | | Class Quiz |
| 19,20 | Solar radiation geometry | Solve the geometry angles related to intensity of solar | Activity (Think Pair Share) | | Class Quiz |
| 21,22 | Principles of wind power | Explain the working of wind turbines | Lecture | [1758.6] | Class Quiz |
| 23,24 | Total power, maximum power ( Betz theory), Actual power | Apply the mathematical relations to find out the power generated by wind turbines | Flipped Class | | Class Quiz |
| 25,26 | Types of windmill | Explain about different windmills according to their design and working | Lecture | [1758.4] | Class Quiz |
| 27,28 | Wind turbine operation | Explain the operational differences of different wind turbines | Lecture | | Class Quiz |

| | | | | | |
|---|---|---|---|---|---|
| 29 | Forces on the blades and thrust on turbines | Calculate the forces activating on turbine | Activity (Think Pair Share) | [1758.6] | Home Assignment<br>Class Quiz |
| 30,31 | Ocean energy | Identify how the energy can be extracted by the ocean | Jigsaw | [1758.4] | Class Quiz |
| 32 | Small scale Hydel Plant | Design a small scale plant which is extracting the energy from water | Activity (Think Pair Share) | [1758.5] | Class Quiz |
| 33,34 | Geothermal energy conversion | Brief and identify the way to convert or use of geothermal energy | Lecture, Activity | [1758.4] | Class Quiz |
| 35,36 | Types of biomass | Explain about the ways from biomass can be produced | Lecture, Jigsaw | | Home Assignment<br>Class Quiz |
| 37,38 | Biogas production from organic waste by an aerobic fermentation | Create & Justify the process of biogas production | Flipped Class, Jigsaw | [1758.4] | Class Quiz |
| 39,40 | Conversion of thermal energy into electricity - Thermo-electric converters | Clarify the conversion technique through thermos-electric convertors | Flipped Class | [1758.5], [1758.6] | Class Quiz |
| 41,42 | Thermal energy storage | Clarify the energy storage and materials | Flipped Class | [1758.5] | Class Quiz |
| 43,44 | Organic and inorganic phase change materials | Classifications and properties | Lecture, Flipped Class | [1758.5], [1758.6] | Home Assignment<br>Class Quiz |

## 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 | PSO3 |
| ME 1758.1 | Analyse the main sources of energy and their primary applications in the INDIA, and the world. | 2 | | | | | | | | | | | | | | |
| ME 1758.2 | Evaluate the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment. | | 3 | | | | | 2 | | | | | | | | |
| ME 1758.3 | Create remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources. | | | 3 | | 2 | | 2 | | | | | | | | |
| ME 1758.4 | Select the primary renewable energy resources and technologies. | | | | | 3 | | | | | | | | | | |
| ME 1758.5 | Develop the basic electrical concepts and system components related to renewable sources. | 2 | | 3 | | | | | | | | | | 2 | | 2 |
| ME 1758.6 | Thermal energy storage | | | | | | 2 | | | 2 | | | | | | |

# MANIPAL UNIVERSITY JAIPUR

School of Automobile, Mechanical and Mechatronics Engineering
Department of Mechanical Engineering
Course Hand-out
Computational Fluid Dynamics| ME 1760 | 3 Credits | 3 0 0 3
Session: July 20 – Dec 20 | Faculty: Dr.Abhishek Sharma/B.Tech.: VII Semester (Program Elective)

A. **Introduction:** This course is offered by Dept. of Mechanical Engineering for VII Semester students, targeting students who wish to pursue research & development in industries or higher studies in the field of Mechanical Engineering. Computational Fluid Dynamics (CFD) is a technology based on a fast and reliable computational methodology for solving complex fluid flow and heat transfer problems. This course provides an introduction to the scientific principles and practical engineering applications of CFD. It provides an overview of some of the fundamental mathematical equations governing the fluid flow and heat transfer phenomena, which help the participants apply the knowledge gained into practical use of commercial CFD codes, particularly ANSYS Fluent.

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

**[ME 1760.1]** Explain basic knowledge of computational methods in fluid flow applications.

**[ME 1760.2]** Understand to select the proper governing equations for the physics involved in the system to solve for the flow, to investigate the fluid-flow behavior, and to interpret computational results.

**[ME 1760.3]** Analyze initial boundary conditions and be able to solve CFD problems.

**[ME 1760.4]** Understand the importance of efficient grid to obtain maximum accuracy of any numerical scheme.

**[ME 1760.5]** Apply Finite difference, Finite element and Finite volume methods in CFD modeling which will enhance the research skills of the students.

## 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.

**PROGRAM SPECIFIC OUTCOMES:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Rubrics:

| Criteria | Description | Maximum Marks |
|---|---|---|
| Internal Assessment (Summative) | Sessional Exam I (Close Book) | 15 |
| | Sessional Exam II (Close Book) | 15 |
| | Quizzes (Open Book/Close Book) and Assignments | 30 |
| End Term Exam (Summative) | End Term Exam (Close Book) | 40 |
| | Total | 100 |
| Attendance | A minimum of 75% Attendance is required to be maintained | |

| | |
|---|---|
| (Formative) | 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

Introduction: Conservation equations, Mass, Momentum and Energy equations, Convective forms of the equations and general description. Transformation from non-conservative form to conservative form, Classifications of boundary conditions, Implementation of boundary conditions in CFD, Staggered Grid, Flow chart and discussion. Navier-Stokes equations: Explicit and implicit methods, SIMPLE type methods. Discretization process: Concept and structure, Finite Difference Technique, Finite Element Method, Finite Volume Technique

## .F. Text Book:

T1. J.D. Anderson Jr., Computational Fluid Dynamics- The Basics with Applications, International Edition, McGraw Hill Education, 1st Edition, 1995.
T2. S.V. Patankar, Numerical Heat Transfer and Fluid Flow - Hemisphere, CRC Press, 2017. T3. H.K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics- The Finite Volume Method, Prentice Hall, 2nd Edition, 2007.

## G. Reference Book:

R1. K. Muralidhar and T.Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 2009.
R2. D.A. Anderson, J.C.Tannehill, and R.H.Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor and Francis Group, 1997.

## H. Lecture Plan:

| Lec No | **Topics** | **Session Objective** | **Mode of Delivery** | **Corresponding CO** | **Mode of Assessing the Outcome** |
|---|---|---|---|---|---|
| 1 | Course Hand-out briefing | To acquaint teacher's expectations and understand student expectations | Lecture | NA | NA |
| 2,3 | Introduction to computational fluid dynamics | Know the basics of the course and understand its applications | Lecture/PPT | ME 1760.1 | Home Assignment and Class Quiz |
| 4 | Conservation equations | Brief about the basics of Fluid | Lecture/PPT | ME 1760.2 | Mid-Term I End-Term |

| | | | | | |
|---|---|---|---|---|---|
| | | mechanics, governing equations of fluid flow | | | |
| 4,5 | Conservation equations of mass | Description of various flow features | Lecture/PPT | ME 1760.2 | |
| 6,7,8 | Conservation equations of momentum | Importance of momentum equation in CFD | Lecture/PPT | ME 1760.2 | Home Assignment and Class Quiz Mid-Term I End-Term |
| 9,10 | Conservation equations of Energy | Understand the flow of energy | Lecture/PPT | ME 1760.2 | |
| 11 | Review and Class Quiz | Assessment and Revision of concepts | Lecture/PPT | | |
| 12,13 | Convective forms of the equations and general description. | gain experience on solving different types of equations | Lecture/PPT | ME 1760.3 | Home Assignment and Mid-Term II End-Term |
| 14,15 | Transformation from non-conservative form to conservative form, | gain experience on solving different types of equations | Lecture/PPT | ME 1760.3 | |
| 16,17 | Classifications of boundary conditions | Initial and Boundary Conditions | Lecture/PPT | ME 1760.3 | Home Assignment and Class Quiz Mid-Term II End-Term |
| 18,19 | Implementation of boundary conditions in CFD | Practical guidelines of boundary condition | Lecture/PPT | ME 1760.3 | |
| 20 | Review and Class Quiz | Assessment and Revision of concepts | Lecture/PPT | ME 1760.4 | |
| 21,22 | Staggered Grid, Flow chart and discussion | Understand how grids are generated | Lecture/PPT | ME 1760.4 | Home Assignment and Class Quiz Mid-Term II End-Term |
| 23,24,25 | Navier-Stokes equations | Understand both flow physics and mathematical | Lecture/PPT | ME 1760.2 | Home Assignment and Class Quiz |

| | | | | | |
|---|---|---|---|---|---|
| | | properties of governing Navier-Stokes equation | | | End-Term |
| 26,27 | Explicit and implicit methods | Learn the solutions of time-dependent ordinary and partial differential equations | Lecture/PPT | ME 1760.4 | Home Assignment and Class Quiz End-Term |
| 28,29 | SIMPLE type methods. | Application of partial differential equation in CFD | Lecture/PPT | ME 1760.4 | |
| 29,30,31 | Discretization process: Concept and structure, | Computational methods of discretization | Lecture/PPT | ME 1760.4 | Home Assignment and Class Quiz End-Term |
| 32 | Review and Class Quiz | Assessment and Revision of concepts | Lecture/PPT | | |
| 33,34,35 | Finite Difference Technique | Understand elementary finite difference coefficients, basic aspects of finite difference equations, | Lecture/PPT | ME 1760.5 | Home Assignment and Class Quiz End-Term |
| 36,37,38 | Finite Element Method | Elementary concepts of FEM | Lecture/PPT | ME 1760.5 | Home Assignment and Class Quiz End-Term |
| 39,40,41 | Finite Volume Technique. | Introduction, Application of FVM in diffusion and convection problems | Lecture/PPT | ME 1760.5 | Home Assignment and Class Quiz End-Term |
| 42 | Review and Class Quiz | Assessment and Revision of concepts | Lecture/PPT | | NA |

**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 |
| ME 1760.1 | Explain basic knowledge of computational methods in fluid flow applications. | 3 | 3 | 2 | 2 | | | | | | | | | | | |
| ME 1760.2 | Understand to select the proper governing equations for the physics involved in the system to solve for the flow, to investigate the fluid-flow behavior, and to interpret computational results. | 3 | 3 | | 2 | | | | | | | | 1 | | | |
| ME 1760.3 | Analyze initial boundary conditions and be able to solve CFD problems. | 3 | 3 | | | 3 | | | | | | | 2 | 2 | | |
| ME 1760.4 | Understand the importance of efficient grid to obtain maximum accuracy of any numerical scheme. | 3 | 2 | | | | | | | | | | | | | |
| ME 1760.5 | Apply Finite Difference, Finite Element and Finite Volume methods in CFD modeling which will enhance the research skills of the students. | 3 | 2 | | 3 | 3 | | | | | | | 3 | 2 | | |

# MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

Seminar | ME 1780 | 3 Credits | 0 0 1 0

Session: July –Nov 20 | Faculty: Vijay Shankar/Ashish Goyal/GSS Aditya | Class: VIth Semester

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering, industrial training is a very important programme since it complements both the academic and professional aspects of the engineering education though it takes only about 6-8 weeks period of training. Exposing the students to the practical experience and actual working environment shall open the avenues for developing their skills and capabilities, as well as enhancing their intellectual and emotional Persona. Students are expected to have background knowledge on basic engineering problems, fundamental mechanical course for a better learning.

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

**[ME 1781.1]** Demonstrate competency in relevant engineering fields through problem identification, formulation and solution

**[ME 1781.2]** Develop the ability to work as an individual and in group with the capacity to be a leader or manager as well as an effective team member

**[ME 1781.3]** Increase in employability by working at industrial project

**[ME 1781.4]** Master the professional and ethical responsibilities of an engineer

## 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.

**Programme Specific Outcomes:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| End Term Exam (Summative) | End Term Exam (presentation and report submission) | 100 (Knowledge-20, Presentation-30, Report-30, Ans. Of query-20) |
| | 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. | |

## E. SYLLABUS

Each student has to give presentation on industrial training. The presentation time is a minimum of 30 minutes followed by a 10 minutes' session for discussion/ question & answers; Each student has to submit to the department a Project report at least three days before the day of seminar; Each student has to make the presentation with LCD projector

**F. 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 |
| **[ME 1781.1]** | Demonstrate competency in relevant engineering fields through problem identification, formulation and solution | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |
| **[ME 1781.2]** | Develop the ability to work as an individual and in group with the capacity to be a leader or manager as well as an effective team member | 1 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 1 | 2 | 3 | 1 | 1 |
| **[ME 1781.3]** | Increase in employability by working at industrial project | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |
| **[ME 1781.4** | Master the professional and ethical responsibilities of an engineer | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |

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

Summer/Industrial Training| ME 1781 | 3 Credits | 0 0 1 0

Session: July –Nov 20 | Faculty: Vijay Shankar/Ashish Goyal/GSS Aditya | Class: VIth Semester

**A. Introduction:** This course is offered by Dept. of Mechanical Engineering, industrial training is a very important programme since it complements both the academic and professional aspects of the engineering education though it takes only about 6-8 weeks period of training. Exposing the students to the practical experience and actual working environment shall open the avenues for developing their skills and capabilities, as well as enhancing their intellectual and emotional Persona. Students are expected to have background knowledge on basic engineering problems, fundamental mechanical course for a better learning.

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

**[ME 1781.1]** Demonstrate competency in relevant engineering fields through problem identification, formulation and solution

**[ME 1781.2]** Develop the ability to work as an individual and in group with the capacity to be a leader or manager as well as an effective team member

**[ME 1781.3]** Increase in employability by working at industrial project

**[ME 1781.4]** Master the professional and ethical responsibilities of an engineer

## 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.

**Programme Specific Outcomes:**

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## D. Assessment Plan:

| Criteria | Description | Maximum Marks |
|---|---|---|
| End Term Exam (Summative) | End Term Exam (presentation and report submission) | 100 (Knowledge-20, Presentation-30, Report-30, Ans. Of query-20) |
| | 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. | |

## E. SYLLABUS

Each student has to give presentation on industrial training. The presentation time is a minimum of 30 minutes followed by a 10 minutes' session for discussion/ question & answers; Each student has to submit to the department a Project report at least three days before the day of seminar; Each student has to make the presentation with LCD projector

**F. 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 |
| **[ME 1781.1]** | Demonstrate competency in relevant engineering fields through problem identification, formulation and solution | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |
| **[ME 1781.2]** | Develop the ability to work as an individual and in group with the capacity to be a leader or manager as well as an effective team member | 1 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 1 | 2 | 3 | 1 | 1 |
| **[ME 1781.3]** | Increase in employability by working at industrial project | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |
| **[ME 1781.4** | Master the professional and ethical responsibilities of an engineer | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |

**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

Major Project | Code: ME-1881 | 12 Credits | 0 0 0 12

Session: Jan. 21 – May 21 | Faculty: Dr Ravi Kumar Sharma | Class: VIII Semester

## A. Introduction:

This course is offered by Dept. of Mechanical Engineering as a final year project, represents the culmination of study towards the Bachelor of Engineering degree in Mechanical Engineering. Projects offer the opportunity to apply and extend material learned throughout the program assessment is by means of a midterm presentation, submission of thesis and public demonstration of work undertaken.

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

**[ME1881.1].** Demostrate a sound technical skill and knowledge of Mechanical Engineering for better employability.

**[ME1881.2].** Plan, analyze, design and implement a hardware/simulation-based project and gather knowledge over the field of research and design about the proposed work.

**[ME1881.3].** Demonstrate knowledge of contemporary issues in their chosen field of research.

**[ME1881.4].** Communicate with engineers and the community at large in written and oral forms.

## A. 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.

**[PSO.1].** Model and analyze Mechanical Engineering systems and components.

**[PSO.2].** Design and performance evaluation of energy systems.

**[PSO.3].** Testing of materials and analysis of manufacturing processes for mechanical engineering applications.

## B. Assessment Rubrics:

| Parameters | Maximum Marks |
|---|---|
| Mid-term report | 10 |
| Mid-term Presentation | 15 |
| Work done/Results (Guide) | 10 |
| Mid-term Viva-voce | 15 |
| End-term viva voce | 50 |
| **Total** | **100** |

**A. 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 | PSO3 |
| **ME1881.1** | Demostrate a sound technical skill and knowledge of Mechanical Engineering for better employability. | 3 | | | 2 | 2 | 2 | | 3 | | | 1 | 2 | 3 | 2 | 2 |
| **ME1881.2** | Plan, analyze, design and implement a hardware/simulation-based project and gather knowledge over the field of research and design about the proposed work. | 2 | 3 | 3 | 2 | | 2 | | 3 | 3 | | 3 | 2 | 1 | 1 | 1 |
| **ME1881.3** | Demonstrate knowledge of contemporary issues in their chosen field of research. | 3 | 2 | | 2 | 1 | 2 | 3 | 3 | 2 | | 2 | 2 | 2 | 1 | 3 |
| **ME1881.4** | Communicate with engineers and the community at large in written and oral forms. | 3 | | | | 2 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 1 | 2 |

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