MANIPAL UNIVERSITY
JAIPUR

INSPIRED BY LIFE

List of Course Hand-outs

(Odd and Even Semester)

Department of Mechatronics Engineering SAMM

Manipal University Jaipur (RJ)

MANIPAL UNIVERSITY
JAIPUR

School of Automobile, Mechanical, Mechatronics Department of Mechatronics Engineering

Vision, Mission and PEOs of the Department

Vision

Global excellence in Mechatronics domain to provide innovative solution for industrial advancements and societal challenges.

Mission

- Provide outcome-based learning to fulfil industrial needs by nurturing inter-disciplinary knowledge for enhancing academic and professional excellence.
- Impart value-based education with state-of-the-art academic environment, humanistic values, and peer teaching-learning approach for enhancing employability and entrepreneurship skills.
- Encourage inter-disciplinary approach to foster research and innovative ideas for smart Mechatronics system by experiential learning.
- Provide opportunity to exhibit and enhance lifelong learning skills with ethical values and social relevance.

Program Educational Objectives

- **PEO-1:** To understand, analyse, design, and develop the mechatronics system using modern tools and technologies to meet the industrial needs.
- **PEO-2:** Prepare graduates to pursue higher studies by enhancing analytical and problem-solving skills in inter-disciplinary engineering for research and innovation.
- **PEO-3:** Graduates of the programme will exhibit life-long learning skills, entrepreneurship competencies and ethical values for a successful professional career and societal needs.

PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

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

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

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

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

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

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

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

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

[PO.9].Individual and teamwork: 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] Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

MANIPAL UNIVERSITY
JAIPUR

Department of Mechatronics Engineering/School of Automobile, Mechanical and Mechatronics Engineering

Manipal University Jaipur

Course Handout- (2017-18)

MANIPAL UNIVERSITY JAIPUR

School of Humanities and social sciences

Department of Economics
Course Hand-out

Economics | EO 1323 | 3 Credits | 3 0 0 3

Session: July 17 – November 17 | Faculty: Dr Manas Roy | Class: B. Tech (Mechatronics) | Semester III

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 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 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 Mid Term I
12	Revision of previous lectures	Recall all the concepts discussed in previous classes	Lecture	1323.5	Class Test Mid Term I End Term
13	Discussion of the topics related to assignment	Discussion about the assignment topics	Lecture, Activity		Home Assignment Mid Term 1 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 Mid Term I 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 Mid Term II 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 Mid Term II 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 Mid Term II End Term
24	Revision of previous lectures	Recall all the concepts discussed in previous classes	Lecture	1323.5	Class Test Mid Term II End Term
25	Discussion of the topics related to assignment	Recall the discussion about the assignment topics	Lecture, Activity	1323.5	Home Assignment Mid Term II End term
26	Capital budgeting	Interpret and illustrate the concept of CB and various tools	Lecture	1323.2	Home Assignment Class Test 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 Class Test 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 Class Test End Term
34,35	Inflation	Concept of inflation, Aware of demand pull and cost push inflation	Lecture	1323.3	Home Assignment Class Test 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 Class Test 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

J. Course Outcome Attainment Level Matrix

CO	STATEMENT	ATTAINMENT OF PROGRAM OUTCOMES **THRESHOLD VALUE: 40%**												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
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			

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

MANIPAL UNIVERSITY JAIPUR

SCHOOL OF AUTOMOBILE, MECHANICAL AND MECHATRONICS (SAMM)

DEPARTMENT OF MECHATRONICS.

COURSE HAND-OUT

Value Ethics & Governance | HS 1301 | 2 Credits | 2 0 0 2

Session: Jan 18 – May 18 | Faculty : Dr. Arun Kumar Deshmukh | Class: CORE

A. **Introduction:** This course is offered by Department of Mechatronics.

This course is designed to imbibe the ethical culture and values in the upcoming professionals. It emphasizes on inculcation of values, creating harmony, developing and learning ethics & develop an understanding of governance issues related to corporate

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

HS1301.1: Identify the nature and theoretical underpinnings of business ethics.

HS 1301.2: Explain the nature of corporate governance.

HS 1301.3: Express the arguments stemming from a range of perspectives on the purposes and responsibilities of businesses and professionals.

HS 1301.4: Assess the relationship between ethics, corporate citizenship, governance and professional advisors.

HS 1301.5 Analyse ethical issues and formulate recommendations for their management.

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

On completion of the B.Tech (Mctx) degree the Computer and Communication Engineering graduates will be able to

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

PO2. Problem analysis: The sophisticated curriculum would enable a graduate to identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using basic principles of mathematics, computing techniques and communication engineering principles.

PO3. Design/development of solutions: Upon analyzing, the B Tech Mctx graduate will be able to devise solutions for complex engineering problems and design system components or processes that meet the specified requirements with appropriate consideration for law, safety, cultural & societal obligations with environmental considerations.

PO4. Conduct investigations of complex problems: To imbibe the inquisitive practices to have thrust for innovation and excellence that leads to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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

PO6. The engineer and society: The engineers are called society builders and transformers. B. Tech Mctx graduate will be able to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: The zero effect and zero defect is not just a slogan, it is to be practised in each action. Thus a B Tech Mctx should understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Protection of IPR, staying away from plagiarism are important. Student will be able to apply ethical principles and commit to professional ethics, responsibilities and norms of the engineering practice.

PO9. Individual and team work: United we grow, divided we fall is a culture at MUJ. Thus an outgoing student will be able to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively for all engineering processes & activities with the peer engineering team, community and with society at large. Clarity of thoughts, being able to comprehend and formulate effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

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

Program Specific Outcomes (PSOs)

At the end of the B Tech Mechatronics program, the student:

[PSO.1]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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	30
	Averaged)	
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.

E. SYLLABUS

Values: Meaning of value education, Three Gunas and their relevance, Nature and kinds of value, Understanding Harmony at various Levels: Nature, in existence; **Ethics and Business:** Values and attitudes for professional accountants, Legal frameworks, regulations and standards for business, Nature of ethics and its relevance; Rules-based and framework approaches to ethics; Personal development and lifelong learning; Personal qualities; Ethical principles; Concepts of independence, skepticism, accountability and social responsibility; **Ethical Conflict:** Relationship between ethics, governance, the law and social responsibility, Unethical behaviour, Ethical dilemmas and conflicts of interest; **Corporate Governance:** The role and key objectives of organizattional governance in relation to ethics and the law; development of organizattional governance internationally; the role of directors in relation to corporate governance; the role of the board, Types of board structures and corporate governance issues, Policies and procedures for 'best practice' companies, Rules and principles based approaches to corporate governance.

F. TEXT BOOKS

1. *Business Ethics & Corporate Governance, Ghosh, B.N., Tata McGraw Hill.*
2. *Corporate Governance, Principles Policies & Practices, Fernando A.C., Pearson*

G. REFERENCE BOOKS

Perspectives and Business Ethics, Hartman and Chatterjee, Tata McGraw Hill.

Professional Ethics, Subramanian, Oxford University Press.

H. Lecture Plan:

LEC NO	TOPICS	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
Class	**Topic**	**Lecture**	**NA**	**NA**
1	Brief Introduction, Expectation Exchange and Meaning of Value	Lecture	HS1301.1	In Class Quiz
2	Where is the need for value education	Lecture	HS1301.1	In Class Quiz End Term
3	Types of values ,three gunas and Understanding Harmony at various Levels	Activity Based Learning	HS1301.1	Home Assignment End Term
4	Ethics and Business	Lecture	HS1301.1	In Class Quiz End Term

5	Do businesses require ethics?	Lecture	HS1301.1 & HS1301.3	Class Quiz Mid Term I End Term
6	Value preposition	Lecture	HS1301.1 and HS1301.5	Class Quiz Mid Term 1 End term
7	Relationship between shareholders with customers, employees and community	Lecture	HS1301.4 and HS1301.5	Home Assignment Class Quiz Mid Term 1 End Term
8	Legal frameworks, regulations and standards for business,	Lecture	HS1301.3	Class Quiz Mid Term 1 End Term
9	Nature of ethics and its relevance; Rules-based and framework approaches to ethics	Lecture	HS1301.2	Class Quiz Mid Term I End Term
10	Personal development and lifelong learning; Personal qualities	Lecture	HS1301.3	Class Quiz End Term
11	Ethical principles; Concepts of independence	Lecture	HS1301.1	Class Quiz Mid Term II End Term
12	Skepticism, accountability and social responsibility;	Lecture	HS1301.1	Class Quiz End Term
13	Ethical Conflict: Relationship between ethics, governance,	Lecture	HS1301.1	Class Quiz Mid Term II
				End Term
14	Law and social responsibility	Lecture	HS1301.1	Class Quiz Mid Term II End Term
15	Unethical behaviour, Ethical dilemmas and conflicts of interest	Lecture	HS1301.1	Class Quiz End Term
16	Objectives of CG and role of CG in respect of ethics and law	Lecture	HS1301.2	Class Quiz End Term
17	Development of organizattional governance internationally	Lecture	HS1301.2	Class Quiz Mid Term II End Term

18	The role of directors in relation to corporate governance; the role of the board, Types of board structures	Lecture	HS1301.2	Class Quiz Mid Term II End Term
19	Corporate governance issues	Case Study	HS1301.2	Class Quiz Mid Term I End Term
20	CG polices	Case Study	HS1301.2	Class Quiz Mid Term I End Term
21	CG principles	Lecture	HS1301.2	Class Quiz Mid Term I End Term
22	CG best practices	Case Study	HS1301.2	Class Quiz Mid Term I End Term
23	Presentations	Students' presentation		Class Quiz End Term
24	Presentations	Students' presentation		Class Quiz End Term

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

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES										
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
HS1101.1	Identify the nature and theoretical underpinnings of business ethics.			1					2			
HS 1101.2	Explain the nature of corporate governance.						1		2			
HS 1101.3	Express the arguments stemming from a range of perspectives on the purposes and responsibilities of businesses and professionals.								2			
HS 1101.4	Assess the relationship between ethics, corporate citizenship, governance and professional advisors.						1		2			
HS 1101.5	Analyze ethical issues and formulate recommendations for their management.					1			2			

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

J. Course Outcome Attainment Level Matrix:

CO	STATEMENT	ATTAINMENT OF PROGRAM OUTCOMES **THRESHOLD VALUE: 40%**												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	PSO 4
HS1101.1	Identify the nature and theoretical underpinnings of business ethics.	1						3	3				1				
HS 1101.2	Understand the nature of corporate governance.			3		1	3					1	1	1	1	1	1
HS 1101.3	Understand the arguments stemming from a range of perspectives on the purposes and responsibilities of businesses and professionals.	1		2	1	1	3	3	3	1	1						

HS 1101.4	Assess the relationship between ethics, corporate citizenship, governance and professional advisors.	1				1		2					2			1	1
HS 1101.5	Analyze ethical issues and formulate recommendations for their management.	1			1			3	3						1	1	1

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

MANIPAL UNIVERSITY JAIPUR

DEPARTMENT OF Mechatronics ENGINEERING

Course Hand-out

Engineering Mathematics III | MA 1313| 3 Credits

Session: July17- Nov 17 | Faculty: Dr. Laxmi Poonia

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

[1313.1] Analysis the problems of engineering by using Numerical analysis.

[1313.2] Solve the differential equations by using Laplace and Fourier transform.

[1313.3] Study the Flux and motion of fluid in the vector field.

[1313.4] Analysis and study the properties of periodic functions by Fourier series.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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

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

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

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

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

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

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

Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

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

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

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

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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

E. SYLLABUS

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

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.

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.

F. Lecture Plan:

Description of the Topics	**Required Lectures**	**Cumulated Lectures**
Laplace Transform:		
Definition of LT. LT of elementary functions, Sectionally Continuous and Exponential order, Existence theorem	1	1
Properties of LT: linearity, First shifting, second shifting, change of scale, Multiplication by t, division by t, Derivative property, Integral Prop.,Initial Value Problem, Final Value Problem (Without Proof)	3	4
Inverse transforms, convolution theorem.	2	6
Application of Laplace in solutions of differential equations with constant coefficients.	1	7
Finite Differences and Interpolation		
Finite difference operators	1	8
Newton’s- Gregory forward and backword interpolation formula,	2	10
Stirling interpolation & Lagrange’s	2	12
Numerical Differentiation (For Forward, Backward, Stirling)	2	14
Numerical Integration(Quadrature formula, Trapezoidal rule, Simpson 1/3rule, Simpson’s 3/8 rule, Weddle rule	3	17
Vector Calculus:		
gradient, divergence and curl	3	20
vector integrals	3	23
Greens, Stokes and Gauss Divergence theorem	4	27
Fourier series:		
Fourier series, Dirichlet Condition	2	29
even and odd functions half range series	1	30
change of interval	2	32
Harmonic analysis	2	34
Fourier Transforms:		
Fourier integrals	1	35
Complex Fourier transform, Fourier sine and cosine transforms,	2	37

Properties of Fourier Transform	2	39
solution of heat and wave equations	3	42
END SEMESTER EXAMINATION		

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
MA1313.1	Analysis the problems of engineering by using Numerical analysis.	2									2			1		
MA 1313.2	Solve the differential equations by using Laplace and Fourier transform.	2			1										2	
MA 1313.3	Study the Flux and motion of fluid in the vector field.	2				1										1
MA 1313.4	Analysis and study the properties of periodic functions by Fourier series.	2									1					

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Strength of Materials | MC1306 | 4 Credits | 4 0 0 4

Session: July 17 – Dec 17 | Faculty: Hemant Kumar | Class: Departmental Core (III sem)

A. INTRODUCTION: This course is offered by Dept. of Mechatronics Engineering as departmental core. Strength of Materials is a fundamental subject needed primarily for the students of Mechanical sciences. As the engineering design of different components, structures etc. used in practice are done using different kinds of materials, it is essential to understand the basic behaviour of such materials. The objective of the present course is to make the students acquainted with the concept of load resultant, consequences and how different kinds of loadings can be withstood by different kinds of members with some specific materials.

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

[MC1306.1] Predict the changes in the mechanical behaviour of materials due to the forces applied on physical models

[MC1306.2] Interpret and quantitatively determine standard mechanical properties from stress-strain diagram.

[MC1306.3] Recognize the fundamental concepts of mechanics of deformable solids; including static equilibrium, geometry of deformation, and material constitutive behaviour.

[MC1306.4] Create interest to explore the analysis and design of engineering structure considering factors of deflection, buckling, and combined loading and failure theories.

[MC1306.5] To build the necessary theoretical background for further structural analysis and design courses.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Rubrics:

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 (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. 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 classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS:

Stress, Strain and Deformation of Solids: Rigid and Deformable bodies, Strength, Stiffness and Stability, Stresses; Tensile, Compressive and Shear, Deformation of simple and compound bars under axial load, Thermal stress, Elastic constants, Strain energy and unit strain energy, Strain energy in uniaxial loads, Beams-Loads and Stresses: Types of beams: Supports and Loads, Shear force and Bending Moment in beams, Cantilever, Simply supported and Overhanging beams, Stresses in beams, Theory of simple bending, Stress variation along the length and in the beam section , Effect of shape of beam section on stress induced , Shear stresses in beams, Shear flow, Torsion: Analysis of torsion of circular bars, Shear stress distribution, Bars of Solid and hollow circular section, Stepped shaft, Twist and torsion stiffness, Fixed and simply supported shafts, Beam deflection: Elastic curve of Neutral axis of the beam under normal loads, Evaluation of beam deflection and slope, Columns, End condition, Equivalent length of a column, Euler equation, Slenderness ratio, Rankine formula for columns, Analysis of stresses in two dimensions: Biaxial state of stresses, Thick & Thin cylindrical shells and spherical shells, Deformation in thick & thin cylindrical and spherical shells, Biaxial stresses at a point, Stresses on inclined plane, Principal planes and stresses, Mohr’s circle for biaxial stresses, Maximum shear stress.

Text Books:

1. E. P. Popov, Engineering Mechanics of Solids, Prentice-Hall of India, New Delhi, 2nd edition, 1998
2. F. P. Beer and R. Johnston, Mechanics of Materials, McGraw-Hill Book Co, 7th edition, 2014.

References:

1. W. A. Nash, Theory and problems in Strength of Materials: Schaum's Outline Series, McGraw-Hill Book Co, 4th Edition, New York 2010.
2. S. M. A. Kazimi, Solid Mechanics, Tata McGraw-Hill, New Delhi, 1st edition, 2001.
3. G. H. Ryder, Strength of Materials, Macmillan India Ltd., 3rd Edition, 2002.
4. Ray Hulse, Keith Sherwin & Jack Cain, Solid Mechanics, Palgrave ANE Books, 2004.
5. D. K. Singh, Mechanics of Solids, Pearson Education, 1st edition, 2002.
6. S. Timoshenko, Elements of Strength of Materials, Tata McGraw-Hill, New Delhi, 5th edition, 2011.

F. Lecture Plan:

Lec. No	**Topics**	**Session Objective**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Introduction , strength of material, Introduction to Stress-Strain diagrams for Ductile and Brittle materials	To understand the importance of Stress-Strain diagrams for materials	Lecture	CO.1	In Class Quiz (Not Accounted)
3,4	Strain Energy, Resilience, Toughness, Hardness, Creep & Temperature, contact stresses, Material Specification	Few definitions for understand the nature of the material properties	Lecture	CO.1	In Class Quiz
5,6	Deformation of simple and compound bars under axial load	Physical meaning of the terms and its usage	Lecture	CO.1	Home Assignment
7.-10	Thermal Stress and strain calculation for composite beam, Numerical practices on thermal stress-strain	To practice numerical on Thermal Stresses	Lecture,	CO.1 & CO.2	In Class Quiz
11	Elastic constants, Strain energy and unit strain energy	Study of Strain Energy and Elastic Constant	Lecture,	CO.2	Home Assignment
12-14	Loads and Stresses: Types of beams, supports and loads, Shear force diagram(SFD) and Bending Moment diagram(BMD), Numerical Practice	Study and practice to check the stresses in system	Lecture	CO.2	Class Quiz
15	Cantilever Beam and related Numerical Problems	To practice the numerical	Lecture	CO.3	Class Quiz
16-17	Simply Supported Beam and related Numerical Problems	To make understand the SFD and BMD	Design Data Book	CO.3	Class Quiz
18-19	Overhanging Beam and related Numerical Problems	Acquaint students about the application of formulas	Lecture	CO.3	Class Quiz, Case Study
20	Theory of Simple bending Stress, Stress variation along the length and in the beam section	Acquaint students about the application of formulas	Flipped Classroom	CO.3	Class Quiz
21	Effect of shape of beam section on stress induced, Shear stresses in beams, Shear flow	Acquaint students about the application of formulas	Flipped Classroom	CO.4	Class Quiz

22-23	Torsion of circular bars, Shear stress distribution	Make students to use formula to solve numerical	Lecture	CO.4	Class Quiz
24-25	Bars of solid and hollow circular section, Stepped shaft, Numerical Practices	Make students to use formula to solve numerical	Lecture	CO.4	Class Quiz

26	Twist and torsion stiffness, Fixed and simply supported beams,	Make students to use formula to solve numerical	Lecture	CO.4	Home Assignment
27	Numerical Practices	Make students to use formula to solve numerical	Lecture	CO.4	Class Quiz
28-29	Elastic curve of neutral axis of the beam under normal loads	Acquaint students about the application of formulas	Lecture	CO.4	Class Quiz
30-31	Beam deflection and its slope, Macaulay's Method	Acquaint students about the application of formulas	Lecture	CO.4	Class Quiz
32-33	Numerical Practices on various types of beams	Make students to use formula to solve numerical	Lecture	CO.4	Class Quiz
34-36	Columns , End conditions, Equivalent length of a column, Formula Derivation	Make students to use formula to solve numerical	Lecture	CO.4	Class Quiz
37-38	Numerical Practices	Make students to use formula to solve numerical	Lecture	CO.4	Class Quiz
39-40	Euler equation, Slenderness ratio and numerical practices	Acquaint students about the application of basic formulas	Lecture	CO.5	Class Quiz
41-42	Introduction to analysis of stresses in two dimensions	Application of formulas	Lecture	CO.5	Class Quiz
43-44	Biaxial state of stresses, Numerical practices	Make students to use formula to solve numerical	Lecture	CO.5	Class Quiz
45	Thick and thin cylindrical shells	Make students to use formula to solve numerical	Lecture	CO.5	Class Quiz
46	Deformations, Biaxial stresses at a point	Make students to use formula to solve numerical	Lecture	CO.5	Class Quiz
47-48	Stresses on inclined plane, Principal planes and stresses	Application of formulas	Lecture	CO.5	Class Quiz
49-51	Mohr's circle for biaxial stresses and Numerical Practice	Make students to use formula to solve numerical	Lecture	CO.5	Class Quiz

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

CO	STATEMENT	CORRELTION 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
MC 1306.1	Course Outcome statement	3	2			3								2		3
MC 1306.2	Course Outcome statement	2	1		2	3								2		3
MC 1306.3	Course Outcome statement	3		3	3	2								2		2
MC 1306.4	Course Outcome statement	3	2	2		2								2		2
MC 1306.5	Course Outcome statement	3		1		3								2		1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Electronic Measurement and Instrumentation | MC1307 | 4 Credits | 4 0 0 4

Session: July 17 – Nov 17 | Faculty: Kumar Gaurav/ O P Gujela | Class: Core Subject

A. INTRODUCTION: This course is electronics based course dealing with measurements and instrumentation designed for students in Physics Electronics, Electrical and Electronics Engineering and allied disciplines. It is a theory course based on the use of electrical and electronics instruments for measurements. The course deals with topics such as Principle of measurements, Errors, Accuracy, Units of measurements and electrical standards, , introduction to the design of electronic equipment's for temperature, pressure, level, flow measurement, resistance, speed etc.

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

CO.1 [MC1307.1] Measure various electrical parameters with accuracy, precision, resolution and understand the errors associated in the measuring devices.

CO.2 [MC1307.2] Explain the use of various electrical/electronic instruments, their construction, principles of operation, standards and Applications

CO.3 [MC1307.3] Analyse different techniques for measurement of inductance, capacitance and resistance employing AC/DC bridges.

CO.4 [MC1307.4] Select appropriate passive or active transducers for measurement of physical phenomenon like temperature, pressure and understand their operation & Construction.

CO.5 [MC1307.5] Methods & Techniques for flow, liquid level, displacement measurement and develop skill for use of these techniques in Industry/Laboratory applications.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

Class Schedule:

3 hours a week, 60 minutes a lecture, 45 lectures a semester.

Contribution of Courses to Meeting Professional Components:

• Basic math and science • Engineering topics

Text Books:

1. A.K. Sawhney, Electrical & Electronic Measurements and Instrumentation, Dhanpat Rai & Co, New Delhi, 19th Edition, 2011.
2. E. O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, New York, 6th Edition, 2012.

References:

1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2010.
2. A. K. Sawhney, A course in Mechanical Measurement and Instrumentation, Dhanpat Rai and Co, New Delhi, 12th edition, 2002.
3. Bela G. Liptak, Process Measurement and Analysis, Chilton Book Company, Pennsylvania, 4th Edition, 2012

Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	15
	Sessional Exam II (Closed Book)	15
	Tutorial Assignment Quiz	5 15 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)	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. 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 classroom participation by a student will be assessed and marks will be awarded.	

SYLLABUS:

Basic concepts of measurements: System configuration, calibration - Errors in measurements, measuring instruments: Permanent magnet moving coil, Moving iron, Electrodynamometer type and Rectifier type instruments, Applications - Measurement of Resistance, Inductance & Capacitance: A.C. Bridges. Temperature Measurement: Temperature and heat, Definitions, temperature scales, bimetallic thermometers, filled-bulb and glass stem thermometers, Resistance Temperature Detector (RTD), principle and types, measuring circuits, Linear and Quadratic approximation Thermistors, Thermocouples, optical pyrometers, Pressure Measurement: Manometers, Elastic types, Bell gauges, Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges, Low Pressure Measurement: Mc Leod gauge, Knudsen gauge, Pirani gauge, Thermal conductivity gauges, Ionization gauge. Flow measurement: Classification of flow meters, orifice meters, Venturi Flow meter, variable area flow meters, Laser Doppler Anemometer (LDA), ultrasonic flow meters, Doppler flow meters, V-cone flow meters, purge flow regulators, Measurement of mass flow rate: Radiation, angular momentum, Displacement measurement (LDR, Photodiode, LVDT), Vibration measurement, Level Measurement, Angular Velocity Measurement

Lecture Plan:

Lec. No	**Topics**	**Session Objective**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Introduction to Measurement and Instrumentation ,Significance of Measurement	To understand the importance of measurement	Lecture	CO.1 & CO.2	In Class Quiz (Not Accounted) End Term Mid term 1
3,4	Methods of Measurement	Few definitions for measurement analysis	Lecture	CO.1 & CO.2	In Class Quiz End Term Mid term 1
5,6	Characteristics of Instruments and Measurement Systems	Physical meaning of the terms and its usage	Lecture	CO.1 & CO.2	Home Assignment End Term Mid term 1
7.-10	Continued, Applications of Measurement System, Calibration - Errors in measurements	Acquaint students on the applications	Lecture, Flipped Classroom	CO.1 & CO.2	In Class Quiz End Term Mid term 1
11	Tutorial	To practice numerical on errors	Quiz	CO.1 & CO.2	Home Assignment Class Quiz
12-14	Permanent magnet moving coil: Introduction, Working, Numerical	Study of electrical instruments	Lecture	CO.3	Class Quiz End Term Mid term 1
15,16	Moving Iron Instruments: Introduction, Working, Numerical	Study of electrical instruments	Lecture	CO.3	Class Quiz End Term Mid term 1
17	Electrodynamometer type Instruments	Study of electrical instruments	Lecture	CO.3	Class Quiz End Term

					Mid term 1
18-19	Rectifier type of instruments	Study of electrical instruments	Software Learning	CO.3	Class Quiz End Term Mid term 1
20	Difference amplifier, instrumentation amplifier and bridge amplifier	Study of amplifiers ad different types	Flipped Classroom	CO.2 & CO.3	Class Quiz End Term Mid term 1
21	Introduction to Bridges	Study of Measurement of resistance, inductance and capacitance using bridges	Flipped Classroom	CO.4	Class Quiz End Term Mid Term 2
22-24	Kelvin's Double bridge, Wheatstone Bridges Numerical	Study of Measurement of resistance, inductance and capacitance using bridges	Lecture	CO.4	Class Quiz End Term Mid Term 2
25	Loss of charge method, Murray Loop Test	Study of Measurement of resistance, inductance and capacitance using bridges	Lecture	CO.4	Class Quiz End Term Mid Term 2
26	Introduction to AC Bridges	Study of Measurement of resistance, inductance and capacitance using bridges	Lecture	CO.4	Class Quiz End Term Mid Term 2
27-30	Anderson Bridge, De-Sauty's Bridge Numerical, Phasor Diagrams	Study of Measurement of resistance, inductance and capacitance using bridges	Lecture	CO.4	Class Quiz End Term Mid Term 2
31-32	Schering Bridge , De-sauty's Bridge, Phasor diagram , Numericals	Study of Measurement of resistance, inductance and capacitance using bridges	Lecture	CO.4	Home Assignment End Term Mid Term 2
33-35	**Temperature Measurement:** Temperature and heat, Definitions, Temperature scales	Study of a transducer used for measuring temperature	Lecture	CO.5	Class Quiz End Term Mid Term 2
36	Bimetallic thermometers	Study of a transducer used for measuring temperature	Lecture	CO.5	Class Quiz End Term Mid Term 2
37	Filled-bulb and glass stem thermometers	Study of a transducer used for measuring temperature	NA, Flipped Classroom	CO.5	NA End Term Mid Term 2
38	Resistance Temperature Detector (RTD), principle and types Measuring circuits	Study of a transducer used for measuring temperature	Practical	CO. 3 & CO.5	End Term Mid Term 2
39-41	Introduction to Thermistors, Linear and Quadratic approximation Thermistors, Numericals	Study of a transducer used for measuring temperature	Lecture	CO.5	End Term Mid Term 2

42	Thermocouples, Types, Properties Applications	Study of a transducer used for measuring temperature	Practical	CO. 3 & CO.5	End Term Mid Term 2
43	**Pressure Measurement:** Manometers	Study of a transducer used for measuring pressure	Lecture	CO.5	End Term
44	U type Manometers, Well type Manometers, bell gauges	Study of a transducer used for measuring pressure	Lecture	CO. 3 & CO.5	End Term
45	Tutorial	To evaluate the students	Quiz	CO.5	End Term
46-48	Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges, Low Pressure Measurement: Mc Leod gauge, Knudsen gauge, Pirani gauge	Study of a transducer used for measuring pressure	Lecture	CO. 3 & CO.5	End Term
49	Thermal conductivity gauges, Ionization gauges	Study of a transducer used for measuring pressure	Seminar	CO. 3 & CO.5	End Term
50-51	**Flow Measurement:** Classification of Flow meter, Laser Doppler Anemometer, Ultrasonic Flow meter	Different types of transducer used for measuring flow measurement	Lecture	CO. 3 & CO.5	End Term
52	Measurement of Mass Flow rate: Displacement (LVDT)	Different types of transducer used for measuring flow measurement	Lecture	CO. 3 & CO.5	End Term
53-55	Angular Velocity Measurement, Angular Momentum Measurement	Different types of transducer used for measuring angular velocity, momentum	Lecture	CO.5	End Term
56	Revision	NA	Quiz	CO.1-CO.5	End Term

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

CO	STATEMENT	CORRELTION 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
MC 1307.1	Measure various electrical parameters with accuracy, precision, resolution and understand the errors associated in the measuring devices.	3		3		**2**									3	
MC 1307.2	Explain the use of various electrical/electronic instruments, their construction, principles of operation, standards and Applications	1		2		1									2	
MC 1307.3	Analyse different techniques for measurement of inductance, capacitance and resistance employing AC/DC bridges.	2		1		2								1	3	
MC 1307.4	Select appropriate passive or active transducers for measurement of physical phenomenon like temperature, pressure and understand their operation & Construction	2		2		1								1	2	
MC 1307.5	Methods & Techniques for flow, liquid level, displacement measurement and develop skill for use of these techniques in Industry/Laboratory applications	1		3		3								1	2	

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

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Analog System Design | MC1308 | 4 Credits | 3 1 0 4

Session: July 17 –Nov 117 | Faculty: Anil Sharma | Class: Department Core

A. Introduction: This course is offered by Dept. of Mechatronics Engineering as third semester subject, targeting students who wish to pursue research & development in industries or higher studies in field of Mechatronics Engineering, including electronics system design and VLSI. This course will cover the basic building blocks of linear systems, such as inverting and non-inverting amplifiers, comparators, and filters.

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

[MC1308.1] Elucidate and design the linear and non-linear applications of an op-amp and special application IC's.

[MC1308.2] Apply the working principle of data converters and filters in practical applications.

[MC1308.3] Analyse the function of application specific ICs such as Voltage regulators, PLL and its application.

[MC1308.4] Assess the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.

[MC1308.5] Design waveform generation and PWM circuits using special application IC 555 and general purpose op-amp for specific applications to enhance employability skills.

B. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.13]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.14]. 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.15]. 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.16]. 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.17]. 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.18]. 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.19]. 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.20]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.21]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.22]. **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.23]. **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.24]. **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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 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.	

SYLLABUS:

Operational Amplifier: Introduction: Introduction to analog system design, Review of Op-Amp basics, internal block diagram, characteristics of ideal operational amplifier, Linear applications of operational amplifier: Open loop and closed loop operation of operational amplifier, Inverting amplifier, non-inverting amplifier, various configuration of Op-Amp, Active filters: Design and analysis of first and higher order low pass, high pass, band pass and band elimination and all pass active filters, Non-linear applications of operational amplifier: Precision half wave and full wave rectifiers, peak detector, sample and hold circuit, log and antilog amplifiers, analog multipliers and dividers, comparators, window detector, Schmitt trigger, square wave, triangular wave generators and pulse generator, Timer: Introduction, pin details of 555 I.C., functional diagram of 555 IC, Multi-vibrators, linear ramp generator and FSK generator, Data converters: Principles of digital to analog converter (DAC) and analog to digital converters (ADC), specifications of ADC and DAC, Regulated power supplies using IC's: Analysis and design of linear series voltage regulators using 78XX and 79XX series, LM317. Current Feedback Op-Amp

D. TEXT BOOKS:

1. Stanley William, *Operational Amplifiers with Linear Integrated Circuits*, Prentice Hall 2004.
2. Ramakant A. Gayakwad, *Op-Amps and Linear Integrated Circuits*, 4th edition, Prentice Hall of India.

E. REFERENCE BOOKS:

1. Milman Jacob, *Microelectronics*, McGraw Hill, 1979.
2. Franco Sergio, *Design with Op amps & Analog Integrated Circuits*, Tata McGraw Hill, 1997.
3. D. L. Terrell, Butterworth, Heinemann, *Op Amps Design, Application, and Troubleshooting*, Elsevier Publications, 1996.
4. D. Roy Choudhury., Shail B. Jain, *Linear Integrated Circuits*, 4th edition, New Age International Publication, 2010.
5. Anand Kumar, *Fundamental of digital circuits*, Prentice Hall of India, 2001.
6. R. L. Boylestad & L. Nashelsky, *Electronic Devices and Circuit Theory*, 8th edition, PHI Learning publications, 2003.

NPTEL >> Electronics & Communication Engineering >> Analog Circuits (Web)

F. Lecture Plan:

Lecture S.no.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
L1	**Introduction**, Basics Of Analog System Design	**NA**	Lecture	**NA**	**NA**
L2	Review Of Concepts - Amplifier Basics	To learn the basics of operational amplifier IC, understand the working principle and pin diagram of IC741	Lecture	CO.1, CO.4	In class quiz
L3	Review Of Op-Amp Basics, Internal Block Diagram		Lecture	CO.1, CO.4	In class quiz
L4	Internal Block Diagram and Characteristics Of Ideal Op-Amp		Lecture	CO.1, CO.4	Sessional Exam
L5	Characteristics Of Ideal Operational Amplifier And Signal Analysis		Lecture	CO.1, CO.4	End semester exam
L6	Frequency Response Analysis - Introduction		Lecture, Presentation	CO.1, CO.4	End semester exam
L7	Frequency Response Analysis Of Op-Amp	Learn the frequency properties of op-amp	Lecture, presentation	CO.4	Home assignment
L8	Numerical Questions Practice		Class activity	CO.4	End semester exam
L9	Linear Applications Of Op-Amp - Introduction	Implement the op-amps in various practical applications and learn their uses.	Lecture	CO.4	Sessional Exam
L10	Linear Applications Of Op-Amp - Open Loop And Closed Loop Operation Of Operational Amplifier		Lecture, presentation	CO.1	Sessional Exam
L11	Inverting Amplifier, Non-Inverting Amplifier		Lecture	CO.1	In class quiz
L12	Different Configurations Of Op-Amp		Lecture, presentation	CO.1	In class quiz
L13	Different Configurations Of Op-Amp		Presentation	CO.2, CO.4	End semester exam
L14	Numerical questions practice		Class activity	CO.2, CO.4	Sessional Exam
L15	**Non-Linear Applications Of Operational Amplifier -** Introduction	Explore the different non-linear applications of op-amp and their implementation Design op-amp circuits for non-linear applications	Lecture, presentation	CO.2, CO.1	In class quiz
L16	Precision Half Wave And Full Wave Rectifiers		Lecture, presentation	CO.2, CO.1	Home assignment
L17	Peak Detector, Sample And Hold Circuit		Presentation	CO.2, CO.1	Home assignment
L18	Sample And Hold Circuit, Log And Antilog Amplifiers		Presentation	CO.2, CO.1	In class quiz
L19	Log And Antilog Amplifiers, Analog Multipliers And Dividers		Presentation	CO.1	In class quiz

L20	Non-Linear Applications – Comparators, Window Detector		Lecture, Class activity	CO.1	In class quiz
L21	Non-Linear Applications - Schmitt Trigger		Lecture, Class activity	CO.1	Sessional exam
L22	Schmitt Trigger and Square Wave		Lecture, presentation	CO.1	Sessional exam
L23	Triangular Wave And Pulse Generators		Lecture	CO.4	Sessional exam
L24	Numerical Questions Practice		Class activity	CO.4	Sessional exam
L25	**Filter Design:** Introduction And Basics Of Passive Filters	Learn about different practical filters, implementation and practical uses Apply the knowledge in practical filter circuit implementation	Lecture	CO.4	In class quiz
L26	Active Filters – Introduction, Design And Analysis Of First Order Low Pass Filter		Lecture, presentation	CO.4	In class quiz
L27	Active Filters –Design And Analysis Of First And Higher Order Low And High Pass Filters		Lecture, presentation	CO.4	Lab implementation
L28	Design And Analysis Of Band Pass Filters		Flipped classroom	CO.1, CO.3	Lab implementation
L29	Band Elimination And All Pass Active Filters		Flipped classroom	CO.1, CO.3	Lab implementation
L30	Numerical Problems		Class activity	CO.1, CO.3	In class quiz
L31	Numerical Problems		Class activity	CO.1, CO.3	In class quiz
L32	**Timer:** Introduction	Learn about pulse width modulation (PWM) in practical applications and implementation using 555 timer IC Design PWM circuits using 555 timer IC	Lecture	CO.5	End Semester exam
L33	Basics Of Multivibrator and Theory		Lecture, flipped classroom	CO.5	End Semester exam
L34	555 IC Timer - Introduction		Lecture	CO.5	End Semester exam
L35	555 IC Timer - Pin Details Of 555 I.C., Functional Diagram Of 555 IC		presentation	CO.5	In class quiz
L36	Working of 555 Timer		Presentation	CO.5	In class quiz
L37	Different modes of 555 Timer		Lecture, presentation	CO.5	Lab implementation
L38	Numerical Practice		Class activity	CO.4, CO.5	Sessional exam
L39	**Data Converters:** Principles Of ADC And DAC	Fundamental understanding of data converters and uses	Lecture	CO.2	End Semester exam
L40	ADC/DAC – Specifications and Configuration		Presentation	CO.2	

L41	DAC – Different types and principle		Lecture	CO.2	End Semester exam
L42	ADC – Different types and principle		Class activity	CO.2	End Semester exam
L43	ADC – Different types and principle		Class activity	CO.2	Class test
L44	Voltage Controlled Oscillator (VCO)		Lecture	CO.2	
L45	Voltage Controlled Oscillator (VCO)		Class activity	CO.2	
L46	Numerical Questions Practice		Class activity	CO.2	
L47	Voltage regulation using Zener diode	Students will learn how to make power supplies using different ICs	Presentation	CO.3	Student presentation
L48	**Regulated Power Supplies** Using IC's		Presentation	CO.3	Student presentation
L49	Analysis And Design Of Linear Series Voltage Regulators Using 78XX And 79XX Series		Presentation	CO.3	Student presentation
L50	Circuit Diagram and Analysis of Lm317		Presentation	CO.3	Student presentation

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
MC1308.1	Elucidate and design the linear and non-linear applications of an op-amp and special application IC's.	3	1		1								1	1	3	
MC1308.2	Classify and comprehend the working principle of data converters.	3	1											1	3	
MC1308.3	Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application.	3		2	2										3	
MC1308.4	Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.	3	2	2										1	3	
MC1308.5	Explain and compare the working of multivibrator using special application IC 555 and general purpose op-amp.	3		2		2								1	3	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Theory of Machines | MC1309 | 4 Credits | 4 0 0 4

Session: July 17 – Nov 17 | Faculty: Mohit Jain | Class: Core subject

A. INTRODUCTION: This course is offered by Dept. of Mechatronics Engineering as a core course. This course is designed to give a clear understanding of the concepts underlying the engineering design. Simple mathematical methods are preferred to design a mechanical mechanism.

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

CO.1 [MC1309.1] Outline the basics of mechanisms and machines like degree of freedom along with type of mechanisms and their equivalent mechanisms.

CO.2 [MC1309.2] Study of velocity analysis – linear velocities of various points on different links of a mechanism as well as the angular velocities of the links.

CO.3 [MC1309.3] Study of acceleration analysis – linear acceleration of various links of a mechanism as well as the angular acceleration of the links which further leads to force analysis of various links of a mechanism.

CO.4 [MC1309.4] To analyse a gear design and gear train. To calculate speed of various gears in gear train and in differential gears.

CO.5 [MC1309.5] To synthesis a mechanical mechanism as per the required motion to enhance employability skills and to understand the concepts of Gyroscope.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

Class Schedule:

4 hours a week, 60 minutes a lecture, 48 lectures a semester.

Contribution of Courses to Meeting Professional Components:

• Basic math and science • Engineering topics

Text Books:

1. Theory of Machines, S.S.Rattan,, McGrawHill
2. Theory of Machines and Mechanisms, Joseph E. Shigley, Oxford University Press

Reference:

1. Kinematics and Dynamics of Machinery, R L Norton, McGrawHill
2. Machines and Mechanisms Applied Kinematic Analysis, David H. Myszka, Pearson

D. Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	15
	Sessional Exam II (Closed Book)	15
	Quizzes and Assignments	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. 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 classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS:

Basic Concepts: Mechanism and machine, kinematic pair, link, chain and inversions, constrained and unconstrained motions, four bar mechanism, single and double slider crank mechanisms with inversions, quick return mechanism, toggle mechanism, Hooke's coupling**. Velocity and Acceleration:** Solution of simple mechanisms by relative velocity and acceleration method, **Cams:** Types of cams, Types of followers, Cam profiles, Graphical methods for simple harmonic motion, Uniform velocity and cycloidal motion, Radial and oscillating follower, Calculation of maximum velocity and acceleration of follower, **Gears:** Classifications, Law of gearing, Spur gear definitions, Involute tooth profile and in voluntometry, Determination of length of path of contact, Arc of contact, Contact ratio, Interference in involute gear, Minimum number of teeth on pinion to avoid interference, Parallel and crossed helical gear, **Gear trains:** Simple, compound, reverted and epicyclic gear train, Solution by tabular column method only, Torque transmitted by epicylic gear train, Bevel epicylic gear train, Differential gear drive of an automobile, **Static and dynamic balancing:** Balancing of revolving masses in single plane and different planes (Graphical method). Balancing of in-line and V-Engine, **Governors:** Characteristics of governors, Porter and proell governor, Hartnell governor, **Gyroscope:** Gyroscopic couple of a spinning disc. Condition for stability of a four wheeler and two wheeler.

H. Lecture Plan:

Lec. No	**Topics**	**Session Objective**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1-3	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	CO.1	NA
4-7	Introduction to degree of mechanisms	To understand the importance of mechanisms	Lecture	CO.1	
8-11	Equivalent mechanisms and type of mechanisms	Application of mechanisms in different machines	Lecture	CO.1	Home Assignment
12-15	Introduction to velocity analysis of kinematic mechanisms	Need to know to reason behind calculating the velocity of links	Lecture	CO.2	
16-18	To calculate velocity of various points of links in mechanisms	To how to calculate velocity in any mechanism	Lecture	CO.2	Home Assignment, Quiz
19-22	Introduction to acceleration analysis of kinematic mechanisms	Need to know to reason behind calculating the acceleration of links	Lecture	CO.3	
23-25	To calculate acceleration of various points of links in mechanisms	To how to calculate acceleration in any mechanism	Lecture	CO.3	Quiz
26-27	Introduction to gears and gear trains	To learn basics of gear design	Lecture	CO.4	
28-30	Calculation of gear trains	To calculate speed of gears in gear train	Lecture	CO.4	Home Assignment
31-32	Introduction to Synthesis	To learn the basics to how to design a mechanism	Lecture	CO.5	
33-37	Function generation and path generation and for finitely separated positions of a rigid body.	To learn how to make dimensional synthesis as per the required path	Lecture	CO.5	

38-41	Synthesis of mechanisms	Design a linkage as per required path and motion	Lecture	CO.5	Home Assignment, Quiz
42-44	Introduction to Gyroscope	Impact of gyroscope and its importance	Lecture	CO.5	
45-48	Gyroscopic effects in aeroplanes, ships, car and bicycle.	To consider the impact of gyroscope in design analysis	Lecture	CO.5	Home Assignment, Quiz

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

CO	STATEMENT	CORRELTION 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
MC 1309.1	Outline the basics of mechanisms and machines like degree of freedom along with type of mechanisms and their equivalent mechanisms	3												2		2
MC 1309.2	Study of velocity analysis – linear velocities of various points on different links of a mechanism as well as the angular velocities of the links		2													1
MC 1309.3	Study of acceleration analysis – linear acceleration of various links of a mechanism as well as the angular acceleration of the links which further leads to force analysis of various links of a mechanism			2										1		1
MC 1309.4	To analyse a gear design and gear train. To calculate speed of various gears in gear train and in differential gears	3	3													1
MC 1309.5	To synthesis a mechanical mechanism as per the required motion to enhance employability skills and to understand the concepts of Gyroscope		2	3	2										3	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Analogue System Design Lab| MC 1331 | 1 Credits | 0 0 2 1

Session: July 17 – Nov 17 | Faculty: Prabhat Ranjan | Class: B. Tech III Sem

A. Introduction: This course is offered by Dept. of Mechatronics Engineering as a lab, targeting students who wish to pursue research& development in industries or higher studies in field of Mechatronics Engineering, including analog signal processing and signal conditioning. Offers hands-on experience on amplifiers, filters, and wave form generators etc.

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

[1331.1]. Implementation of linear applications of op-amp and its practical uses.
[1331.2]. Analyse active filter behaviour and its practical uses.
[1331.3]. Implementation of Non-linear applications of op-amp and its practical uses.
[1331.4]. Design of circuits to get different waveforms and practical applications.

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]. Apply the knowledge of basic sciences, analytical skills, and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 any time 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

Negative feedback amplifiers: inverting and non-inverting mode, Instrumentation amplifier, summer, Voltage follower, Integrators, Differentiators, Filters: low pass filter, high pass filter, Square wave generator, Triangular wave generator, Schmitt trigger: inverting and non- inverting mode, Multi-vibrators using IC 555: Astable multivibrator, Monostable multi-vibrator, Half wave and Full wave precision Rectifier using OPAMP. Voltage regulator using LM317, 7805 ICs.

F. Reference Books

R1. Franco Sergio, Design with Op amps & Analog Integrated Circuits, Tata McGraw Hill, 4th edition, 2014.

R2. D. L. Terrell, Op Amps Design, Application, and Troubleshooting, Elsevier Publications, 2nd edition, 1996.

R3. R. L. Boylestad & L. Nashelsky, Electronic Devices and Circuit Theory, PHI Learning publications, 10th edition, 2009.

G. Lecture Plan:

Lab No	Name of the Experiment	Experiment Outcome	Type of Expt.	Corresponding CO	Mode of Assessing the Outcome
1	Design and Implement an Inverting and Non-inverting amplifier using Op Amp 741	To implement amplifiers using Op amp	Hands-on	1331.1	Observational Data, Viva-Voce
2	Implement a voltage follower circuit using Op Amp 741 b) Design and Implement a summing amplifier using Op Amp 741	Hardware implementation of summing amplifier and voltage follower	Hands-on	1331.1	Observational Data, Viva-Voce
3	Design and Implement a scalar circuit using Op Amp 741 b) Design and Implement an average circuit using Op Amp 741	Hardware implementation of scaler and average circuit	Hands-on	1331.1	Observational Data, Viva-Voce
4	Design and Implement a difference amplifier circuit using Op Amp 741 b) Design and Implement a comparator using Op Amp 741	Hardware implementation of comparator and difference circuit	Hands-on	1331.1	Observational Data, Viva-Voce
5	Design and Implement an integrator circuit using Op Amp 741 for the given wave shapes: (i) Triangular (ii) Square (iii) Sinusoidal	Hardware implementation of integrator circuit	Hands-on	1331.1	Observational Data, Viva-Voce
6	Design and Implement a differentiator circuit using Op Amp 741 for the given wave shapes: (i) Triangular (ii) Square (iii) Sinusoidal	Hardware implementation of differentiator circuit	Hands-on	1331.1	Observational Data, Viva-Voce
7	Design and Implement a Butterworth Low Pass and High Pass Filter using Op-Amp for the given cut-off frequency and obtain its frequency response	Hardware implementation of low and high pass filter	Hands-on	1331.2	Observational Data, Viva-Voce
8	Design and Implement a Butterworth Band Pas Filter using Op Amp 741 for the given cut-off frequencies and obtain its frequency response	Hardware implementation of band pass filter	Hands-on	1331.2	Observational Data, Viva-Voce
9	Design a Schmitt Trigger using Op Amp 741 and verify its output	Hardware implementation of Schmitt trigger	Hands-on	1331.4	Observational Data, Viva-Voce
10	Design and Implement a square wave generator using Op Amp 741 for given frequency	Hardware implementation of square wave generator	Hands-on	1331.4	Observational Data, Viva-Voce
11	Design and Implement Astable Multivibrator using Timer IC 555 for the given time period	Hardware implementation of astable multivibrator	Hands-on	1331.4	Observational Data, Viva-Voce
12	Design and Implement Monostable Multivibrator using Timer IC 555 for the given pulse width	Hardware implementation of monostable multivibrator	Hands-on	1331.4	Observational Data, Viva-Voce
13	Design and Implement Half wave precision rectifier using Op Amp 741	Hardware implementation of half wave rectifier	Hands-on	1331.3	Observational Data, Viva-Voce

14	Design and Implement Full wave precision rectifier using Op Amp 741	Hardware implementation of full wave rectifier	Hands-on	1331.3	Observational Data, Viva-Voce

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

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES									
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
MC 1331.1	Implementation of linear applications of op-amp and its practical uses.								1	2	
MC 1331.2	Analyze active filter behaviour and its practical uses.				1					2	
MC 1331.3	Implementation of Non-linear applications of op-amp and its practical uses.			1	1				1	2	
MC 1331.4	Design of circuits to get different waveforms and practical applications				1	1		2		2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Electronic Measurement and Instrumentation Lab| MC 1332 | 1 Credits | 0 0 2 1

Session: July 17 – Nov 17 | Faculty: Princy Randhawa | Class: B. Tech III Sem

I. Introduction: This course is offered by Dept. of Mechatronics Engineering as a lab, targeting students who wish to pursue research& development in industries or higher studies in field of Mechatronics Engineering, including electrical and electronic instruments. Offers hands-on experience various transducers such as temperature, force, velocity, displacement etc.

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

[MC1332.1] Explain the industrial and laboratory applications of various kinds of Transducers.
[MC1332.2] Analyse and Study the characteristics of Temperature Transducers
[MC1332.3] Analyse and Study the characteristics of Force, Velocity, Displacement Transducers.
[MC1332.4] Study and Analyse the ADC/DAC Converters.

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]. Apply the knowledge of basic sciences, analytical skills, and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

K. 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 any time 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	

L. List of experiments

Experiment -1	Study and perform the characteristics of Thermocouple
Experiment - 2	Study and perform the characteristics of Thermistor
Experiment -3	Study and perform the characteristics of Strain Gauge
Experiment -4	Perform the experiment of Angular velocity Measurement
Experiment -5	Study and perform the characteristics of LDR, Photodiode and Phototransistor
Experiment -6	Perform the experiment of DC Servo Motor Speed Control System
Experiment -7	Study and perform the characteristics of Resistance Temperature Detector
Experiment -8	Study and perform the characteristics of Linear Variable Differential Transformer
Experiment -9	Perform the experiment of Digital to Analog Converter
Experiment -10	Perform the experiment of Piezo-Electric Transducer
Experiment -11	Study and perform the characteristics of Inductive pickup
Experiment -12	Study and perform the characteristics of Capacitive pickup
Experiment -13	Perform the experiment of Hall Effect Transducer
Expreiment -14	Perform the experiment of Analog to Digital converter

M. Reference Books

4. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2010.
5. A. K. Sawhney, A course in Mechanical Measurement and Instrumentation, Dhanpat Rai and Co, New Delhi, 12th edition, 2002.
6. Bela G. Liptak, Process Measurement and Analysis, Chilton Book Company, Pennsylvania, 4th Edition, 2012

N. Lecture Plan:

Lab No	**Name of the Experiment**	**Experiment Outcome**	**Type of Expt.**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Study and perform the characteristics of Thermocouple	Study of a transducer used for measuring temperature	Hands-on	1332.1,2	Observational Data, Viva-Voce
2	Study and perform the characteristics of Thermistor	Study of a transducer used for measuring temperature	Hands-on	1332.1,2	Observational Data, Viva-Voce
3	Study and perform the characteristics of Strain Gauge	Study of a transducer used for measuring force.	Hands-on	1332.1,3	Observational Data, Viva-Voce
4	Perform the experiment of Angular velocity Measurement	Study of a transducer used for measuring velocity .	Hands-on	1332.1,3	Observational Data, Viva-Voce
5	Study and perform the characteristics of LDR, Photodiode and Phototransistor	Study of a transducer used for measuring light.	Hands-on	1332.1,3	Observational Data, Viva-Voce
6	Perform the experiment of DC Servo Motor Speed Control System	Study of a transducer used for measuring Speed .	Hands-on	1332.1,3	Observational Data, Viva-Voce
7	Study and perform the characteristics of Resistance Temperature Detector	Study of a transducer used for measuring temperature	Hands-on	1331.1,2	Observational Data, Viva-Voce
8	Study and perform the characteristics of Linear Variable Differential Transformer	Study of a transducer used for measuring displacement.	Hands-on	1331.1,3	Observational Data, Viva-Voce
9	Perform the experiment of Digital to Analog Converter	Study and Analyse DAC Converter.	Hands-on	1331.1,4	Observational Data, Viva-Voce
10	Perform the experiment of Piezo-Electric Transducer	Study of a transducer used for measuring force.	Hands-on	1331.1,3	Observational Data, Viva-Voce
11	Study and perform the characteristics of Inductive pickup	Study of a transducer used for measuring displacement.	Hands-on	1331.1,3	Observational Data, Viva-Voce
12	Study and perform the characteristics of Capacitive pickup	Study of a transducer used for measuring displacement.	Hands-on	1331.1,3	Observational Data, Viva-Voce
13	Perform the experiment of Hall Effect Transducer	Study of a transducer used for measuring displacement.	Hands-on	1331.1,3	Observational Data, Viva-Voce
14	Perform the experiment of Analog to Digital converter	Study and Analyser ADC Converter.	Hands-on	1331.1,4	Observational Data, Viva-Voce

O. 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
MC 1332 .1	Explain the industrial and laboratory applications of various kinds of Transducers.	2						3	2	2				1	1	1
MC 1332 .2	Analyse and Study the characteristics of Temperature Transducers	2			1			3	2	2				1	1	1
MC 1332 .3	Analyse and Study the characteristics of Force, Velocity, Displacement Transducers	2			1			3	2	2				1	1	1
MC 1332 .4	Study and Analyse the ADC/DAC Converters	2			1	1		3	2	2				1	1	1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mathematics & Statistics

Course Hand-out

Engineering Mathematics IV | MA 1410 | 3 Credits | 3 0 2 3

Session: Jan. 18 – May 18 | Faculty: Dr. Anamika Jain

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 of Numerical analysis, Solution of algebraic and transcendental equations, Solution of differential equations, partial differential equations by numerical methods, Basic knowledge Statistics, Distributions and Tensors. Students are expected to have background knowledge on finding roots of algebraic equations, differential equations, probability, two and three dimensional geometry for a better learning.

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

[1410.1]. Analysis the problems of engineering by using Numerical analysis.

[1410.2]. Solve for the zero of a non-linear algebraic function using bisection and regula- falsi methods, as well as Newton-Raphson and secant iteration methods.

[1410.3]. Solve the ordinary and partial differential equations by using numerical methods.

[1410.4]. Draw normal distribution curve and will be able to compare the results.

[1410.5]. To understand and calculate figures of more than three dimensions.

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]. Autotronics and Electric Vehicle Technology: Apply knowledge of electrical and electronics engineering for providing automobile engineering solutions.

[PSO.2]. Alignment to Super Qualification packs of ASDC: Demonstrate knowledge and performance criteria as defined by ASDC super qualification packs for R&D or Quality or Service Engineering.

[PSO.3]. Application of Lean Six Sigma Methodology: Demonstrate through an internship project, the knowledge and understanding of lean six sigma methodology based on Define, Measure, analyse, improve/develop and control/validate phases (DMAIC/ DMADV).

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Open Book)	10
	Sessional Exam II (Open Book)	10
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	10
	Laboratory Sessions	20
End Term Exam (Summative)	End Term Exam (Open Book)	50
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
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

Tensor: Introduction to tensors, Cartesian tensors, Rank of tensor, First, second and higher order tensors, Algebraic operation on tensors, contraction of tensors, Contravariant and covariant vectors and tensors, Theorem based on tensors.

Solution of Non Linear Equations: Bisection, Newton-Raphson, Regula Falsi, Secant Methods. **System of Simultaneous Linear Equations:** Gauss elimination method, Gauss-Jacobi, Gauss-Seidel. **Solution of Initial Value Problems:** Taylor's series method, Euler method, modified Euler method, Runge-Kutta 4^{th} order method. **Finite Difference Methods:** Solution of Laplace and Poisson equations by standard five point formula, Solution of heat equations by Crank-Nicolson method, Solution of Wave Equations. **Statistics:** Correlation, Regression, Random variables, Probability distributions – Binomial, Poisson, Normal.

F. Text Books:

1. 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. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Education Private Limited, New Delhi 2007.

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	NA
2,3	Solution of Non Linear Equations: Bisection	Recall working of Non Linear Equations	Lecture	1410.1	In Class Quiz (Not Accounted)
4,5	Secant Methods	Identify different numerical problems and describe their formation	Lecture, Activity	1410.1	In Class Quiz End Term
6	Regula Falsi Method	Explain Regula Falsi Method and their formation and solution Processes	Lecture	1410.2	Home Assignment End Term
7,8	Generalized Newton Raphson Method, Newton Raphson Method for a system of non-linear equations	Explain Newton Raphson Method and their formation and properties	Lecture	1410.2	In Class Quiz End Term
9	Solution of system simultaneous Linear Equation- Gauss elimination method	Recall system simultaneous Linear Equation and explain Gauss elimination method	Lecture, Activity	1410.2	Class Quiz Mid Term I End Term
10	Gauss Jacobi	Recall system simultaneous Linear Equation and explain Gauss Jacobi method	Lecture	1410.2	Class Quiz Mid Term 1 End term
11	Gauss Seidel	Recall system simultaneous Linear Equation and explain Gauss Seidel method	Lecture	1410.2	Home Assignment Class Quiz Mid Term 1 End Term
12	Solution of Initial Value Problems- Taylor's series method	Recall Initial Value Problems and explain Taylor's series method and their problems	Lecture	1410.3	Class Quiz Mid Term 1 End Term
13	Euler method	Recall Initial Value Problems and explain Euler method and their problems	Lecture	1410.3	Class Quiz Mid Term I End Term
14	Modified Euler method	Recall Initial Value Problems and explain Modified Euler method and their problems	Lecture	1410.2	Class Quiz End Term
15,16	Runge-Kutta 4^{th} order method	Analyse Initial Value Problems and explain Runge-Kutta 4^{th} order	Lecture, Activity	1410.2	Class Quiz Mid Term II

		method and their problems			End Term
17	**Finite Difference Methods:** Solution of Laplace equations by five point formula	Examine Finite differential methods and their properties and explain solution of Laplace equations by five point formula	Lecture, Activity	1410.3	Class Quiz Mid Term II End Term
18	Solution of Poisson equations by five point formula	Examine Finite differential methods and their properties and explain solution of Poisson equations by five point formula	Lecture, Activity	1410.3	Class Quiz Mid Term II End Term
19	Heat equations	Examine Finite differential methods and their properties and explain solution of Heat equations	Lecture	1410.3	Class Quiz Mid Term II End Term
20,21	Wave equations	Examine Finite differential methods and their properties and explain solution of Wave equations	Lecture	1410.3	Class Quiz End Term
22,23	**Statistics:** Probability, Random Variables	Knowledge of basic concept of probability	Lecture	1410.4	Class Quiz End Term
24,25	Probability Distributions: Binomial Distribution	Understanding of Binomial Distribution	Lecture, Activity	1410.4	Class Quiz End Term
26	Poisson Distribution	Understanding of Poisson Distribution	Lecture, Activity	1410.4	Class Quiz End Term
27,28	Normal Distribution	Understanding of Normal Distribution	Lecture, Activity	1410.4	Class Quiz End term
29,30	Correlation	Knowledge of basic concept of Correlation	Lecture, Activity	1410.4	Class Quiz
31	Regression	Knowledge of basic concept of Regression	Lecture, Activity	1410.4	Class Quiz Mid Term II End Term

32,33	least square principle of curve fitting	Use of curve fitting	Lecture, Activity	1410.4	Class Quiz Mid Term II End Term
34	**Tensor:** Introduction to tensors	Knowledge of basic concept of Tensor	Lecture	1410.5	Class Quiz Mid Term II End Term
35, 36	Cartesian tensors, Rank of tensor	Examine Cartesian tensors, Rank of tensor	Lecture	1410.5	Class Quiz End Term
37	First, second and higher order tensors	Examine First, second and higher order tensors	Lecture	1410.5	Class Quiz End Term
38,39	Algebraic operation on tensors	Describe Algebraic operation on tensors	Lecture	1410.5	Class Quiz End Term
40	Contraction of tensors	Describe Contraction of tensors	Lecture	1410.5	Class Quiz End Term
41	Theorem based on tensors	Describe Theorem based on tensors	Lecture	1410.5	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	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
MA 1410.1	Analysis the problems of engineering by using Numerical analysis.	2				1					2					
MA 1410.2	Solve for the zero of a non-linear algebraic function using bisection and regula-falsi methods, as well as Newton-Raphson and secant iteration methods.	2	2											1	1	1
MA 1410.3	Solve the ordinary and partial differential equations by using numerical methods			1												
MA 1410.4	Draw normal distribution curve and will be able to compare the results.				1											1
MA1410.5	To understand and calculate figures of more than three dimensions	2				1									1	1

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

J. Course Outcome Attainment Level Matrix:

CO	STATEMENT	ATTAINMENT OF PROGRAM OUTCOMES **THRESHOL VALUE: 40%**									
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO
MA1410.1	Course Outcome statement	2				1					2
MA1410.2	Course Outcome statement	2	2								
MA1410.3	Course Outcome statement			1							
MA1410.4	Course Outcome statement				1						
MA1410.5	Course Outcome statement					1					

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering

Course Hand-out

Design of Machine Elements | MC1405 | 4 Credits | 4 0 0 4

Session: Jan 18 – May 18 | Faculty: Hemant Kumar | Class: Departmental Core

A. INTRODUCTION: This course is offered by Dept. of Mechatronics Engineering as departmental core. This course covers the design and analysis of scientific principles. Technical information and innovative ideas for the development of a new or improved machine. It also develops new technical information and imagination in description of a machine or a mechanical system to perform specific functions with maximum economy and efficiency.

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

[MC1405.1] Outline the basics of the critical material properties in design, such as stress, strength and analyse stresses and strains in machine elements and structures subjected to various loads.

[MC1405.2] To interpret how the Quality fatigue analysis take place and along with their specify causes for machine design failure. Analyse the problems associated with fasteners, screws and shafts.

[MC1405.3] Describe about the design of transmission shaft, materials, permissible stresses, design for static and fatigue load, ASME code for shaft design. Design of keys: types of keys, application, stresses in the key, selection of keys.

[MC1405.4] To implement Gear analysis, understand gear train arrangement and force analysis. Standard procedure and their application in static and fluctuating analysis. (Gears: Spur, Helical, Bevel and Worm).

[MC1405.5] Select the suitable bearing, bearing arrangement, material and design various type of bearings (hydrostatic, hydrodynamic, journal bearings), with standard design procedure.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Rubrics:

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 (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. 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 classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS:

Basic Concepts: Fundamentals of Mechanical Design: The Design Process, Economics of Design, Reliability, Safety and Product Liability, Codes and Standards, Types of Materials, Stress-Strain Response, Types Of Loads and Stresses, Failure Modes, Factor of Safety, Strength Design. Static And Variable Stress Analysis: Static Strength, Failure Theories, Stress Concentration, Fatigue Strength, Stress-Life (S-N) Diagram, High Cycle Fatigue, Endurance Limit Modifying Factors, Effect of Mean Stress, Fluctuating Stresses, and Stresses due to Combined Loading. Design of Transmission Shaft: Materials, Permissible Stresses, Permissible Deflection And Permissible Angular Twist, Power Transmitting Elements, Design For Static And Fatigue Load, ASME Code For Shaft Design. Design of Keys: Types of Keys, Application, Stresses in the Key, Selection of Keys. Coil Springs: Helical Coil Spring: Compression Springs of Round/Square/Rectangular Wires, Spring Materials, Stress And Deflection of Spring Subjected to Steady, Fluctuating and Impact Loads, Spring Surge and Buckling, Concentric Springs. Power Screws: Types of Power Screws, Terminology, Torque for Power Screws, Collar Friction, Efficiency, Nut for The Power Screw, Stresses in Power Screws, Threaded Fasteners: Effect of Initial Tension, Load on Axially Loaded Bolt, and Bolts for Pressure Vessels. Gears: Spur and Helical Gears: Merits, Terminology, Tooth Profile, Pressure Angle, Lewis Equation for Beam Strength, Form Factor, Velocity Factor, Design for Static Loads, Design for Dynamic and Wear Loads.

Text Book:

1. J.E. Shigley and C.R. Mischke, Mechanical Engineering Design, McGraw Hill Publication, 7th Edition, 2003.

References Book:

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.

F. Lecture Plan:

Lec. No	**Topics**	**Session Objective**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Introduction to Stress-Strain diagrams for Ductile and Brittle materials	To understand the importance of Stress-Strain diagrams for materials	Lecture	CO.1	In Class Quiz (Not Accounted)
3,4	Strain Energy, Resilience, Toughness, Hardness, Creep & Temperature, contact stresses, Material Specification	Few definitions for understand the nature of the material properties	Lecture	CO.1	In Class Quiz
5,6	Strength Concepts: Principle Stresses, Theories of failure, Factor of Safety	Physical meaning of the terms and its usage	Lecture	CO.1	Home Assignment
7.-10	Fatigue: S-N diagram, Low cycle and high cycle fatigue, Endurance limit, Numerical problems	To practice numerical on Low cycle and high cycle fatigue, Endurance limit mathematically	Lecture,	CO.1 & CO.2	In Class Quiz
11	Variables affecting Fatigue strength, Fluctuating stresses	Study of design	Lecture,	CO.2	Home Assignment Class Quiz
12-14	Goodman & Soderberg equations, Modified Goodman equation, Stresses due to combined loading, Numerical problems	Study and practice to check the stresses in system	Lecture	CO.2	Class Quiz
15	Shafts: Torsion of circular solid & hollow shafts	Introduction of shafts	Lecture	CO.3	Class Quiz
16-17	Design of shafts subjected to bending in two planes in addition to axial loads, Numerical problems	Acquaint students with the detail overview of design data book	Design Data Book	CO.3	Class Quiz
18-19	Keys & Pins: types of Keys and Pins, Stresses in Keys, Design of square Keys	Acquaint students with design of Shaft Key assembly	Lecture	CO.3	Class Quiz, Case Study
20	Design of Rectangular Keys, Design of taper Keys	What are the other types of key	Flipped Classroom	CO.3	Class Quiz
21	Gear & Gear Types and Nomenclature of gears, Fundamentals of gears	Acquaint students about Gear Terminology	Flipped Classroom	CO.4	Class Quiz
22-23	Conjugate action and Involute Properties, selection of gears	How to use properties of gear to select gear	Lecture	CO.4	Class Quiz

24-25	Static Force analysis on gears teeth, Analyses of strength of gear teeth	Analysis for gear strength	Lecture	CO.4	Class Quiz
26	Dynamic Effects of forces on gear teeth, Numerical problems	Make students to use design data book to solve numerical	Lecture	CO.4	Home Assignment
27	Estimation of Gear size with numerical problems	Make students to use design data book to solve numerical	Lecture	CO.4	Class Quiz
28-29	Fatigue Strength and consideration of Factor of safety.	Acquaint students about the application of formulas	Lecture	CO.4	Class Quiz
30-31	Velocity Factor, Design for Static Loads,	Acquaint students about the application of formulas	Lecture	CO.4	Class Quiz
32-33	Design for Dynamic and Wear Loads	Application of formulas as well as Design Data Book	Lecture	CO.4	Class Quiz
34-36	Numerical Problems on Spur gear design	Application of formulas as well as Design Data Book	Lecture	CO.4	Class Quiz
38-40	Helical Gears- Static Force analysis on gears teeth, Analyses of strength of gear teeth	Application of formulas as well as Design Data Book	Lecture	CO.4	Class Quiz
41	Introduction. Type of Rolling contact bearings,	Acquaint students about the application of basic formulas	Lecture	CO.5	Class Quiz
42-44	Principle of self-aligning Bearing, Selection of bearing type, Static Load Carrying Capacity	Application of formulas	Lecture	CO.5	Class Quiz
45	Stribeck's Equation, Dynamic Load Carrying Capacity, Equivalent Bearing Load	Make students to use design data book to solve numerical	Lecture	CO.5	Class Quiz
46-47	Load- Life relationship, Selection of bearing life, load factor, Numerical Problems	Make students to use design data book to solve numerical	Lecture	CO.5	Class Quiz
48	Sliding contact bearing, Viscosity, VI, Petroff's Equation, McKee's Investigation.	Make students to use design data book to solve numerical	Lecture	CO.5	Class Quiz
50-52	Hydrostatic Step Bearing, Energy Losses in Hydrostatic Bearing, Reynold's Equation, Raimondi and Boyd Method.	Application of formulas	Lecture	CO.5	Class Quiz
53-55	Selection of bearing parameters, Temperature rise and Numerical Problems	Make students to use design data book to solve numerical	Lecture	CO.5	Class Quiz

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

CO	STATEMENT	CORRELTION 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
MC 1405.1	Course Outcome statement	3	2			2								2		3
MC 1405.2	Course Outcome statement	2	1		2	3								2		3
MC 1405.3	Course Outcome statement	2		3	3	2								2		2
MC 1405.4	Course Outcome statement	3	2	2		3								1		2
MC 1405.5	Course Outcome statement	3		1	1	2								2		1
MC 1405.6	Course Outcome statement	2		1	2									2		2

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

FLUID MECHANICS AND MACHINES | MC1407 | 4 Credits | 4 0 0 4

Session: Jan-May 18 | Faculty: Dr. Ram Dayal | Class: Dep. Core (IV Sem)

A. Introduction: This course is offered by Dept. of Mechatronics Engineering as a department core, for all the students to enable them to develop an understanding of Newtonian fluids under static and dynamic conditions with the help of appropriate conservation equations. Further to apply the fundamentals for investigating variety of applications including basic pipe flow, fluid machinery, sports etc.

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

[1407.1]. To describe the static and dynamic fluid systems using respective governing equations.

[1407.2]. Devise simple solutions to a range of problems in basic fluid flow

[1407.3]. To apply concepts of mass, momentum and energy conservation to flows

[1407.4]. To able to analyze variety of simplified flow problems theoretically

[1407.5]. Grasp the basic ideas of turbulence and Identify various types of pumps and turbines and know their working principles

C. Program Outcomes and Program Specific Outcomes

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

[PO.2]. Problem analysis:Identify, formulate, research literature, and analyze complex engineeringproblems 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 anddesign 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 researchmethods including design of experiments, analysis and interpretation of data, and synthesis of theinformation to provide valid conclusions

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

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

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

[PO.8]. Ethics: Apply ethical principles and commit toprofessional ethicsand responsibilities andnorms of the engineering practices

[PO.9]. Individual and team work: Function effectively as an individual, and as amember or leader indiverse teams, and in multidisciplinary settings.

[PO.10]. Communication:Communicate effectivelyon complex engineering activities with theengineering 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 theengineering 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 inindependent and life-long learning in the broadest context of technological change

[PSO.1]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design,perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives,instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advancedfunctional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 (Accumulatedand 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 studentto be qualified for taking up the End Semester examination. The allowanceof 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about theabsence. A makeup assignment on the topic taught on the day of absencewill be given which has to be submitted within a week from the date ofabsence. No extensions will be given on this. The attendance for thatparticular day of absence will be marked blank, so that the student is notaccounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/	There are situations where a student may have to work in home, especiallybefore a flipped classroom. Although these works are not graded withmarks. However, a student is expected to participate and perform theseassignments with full zeal since the activity/ flipped classroom participationby a student will be assessed and marks will be awarded.	

E. Syllabus

Fundamentals: Definition and properties of fluids, intensity of pressure, variation of pressure in a static fluid, Absolute, Gauge, Atmospheric and Vacuum pressure Manometers, Fluid statics: Hydro static forces and centre of Pressure on vertical and inclined plane surfaces, Buoyancy, centre of Buoyancy, Metacentre and Meta-centric height, Analytical method for determination of Meta-centric height, Stability of floating and sub-merged bodies, Kinematics and Dynamics of fluid flow : Types of fluid flow, continuity equation, one dimensional Euler's equation of motion, Bernoulli's energy equation, Fluid flow measurements: Pitot tube, orifice meter and venture meter, Fluid flow in pipes: Darcy weisbach equation. Losses in pipes - Minor and major losses, Dimensional analysis and Similitude: Methods of dimensional analysis, similitude, Impact of jet: Force exerted by the jet on stationery vanes and moving vanes, Hydraulic turbines: Pelton turbine, Francis turbine and Kaplan turbine (Constructional feature, working principle Velocity triangle, governing mechanisms and simple problems), Centrifugal pumps: Single-stage and multi-stage pumps - constructional feature, working principle, velocity triangles and simple problems.

F. Text Books

a. Frank M. White, Fluid Mechanics, McGraw Hill, 7th edition, 2011.

b. Yunus A Cengel and John M. Cimbala, Fluid Mechanics, Tata McGraw-Hill Education, 3rd edition, 2010

G. Reference Books

a. Victor Lyle Streeter, E. Benjamin Wylie, Fluid mechanics, McGraw Hill, 9^{th} edition, 2010
b. Pijush K. Kundu, Ira M. Cohen, David R. Dowling, Fluid Mechanics, Academic press, 5th Edition, 2012

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	History and scope of fluid mechanics	Recognize variety of fluid flow problems encountered in practice	Lecture	1407.1	In Class Quiz
3,4,5	Concept of continuum, Thermodynamic properties of a fluid	Gain working knowledge of basic properties of fluids and understand continuum Approximation	Lecture	1407.1	In Class Quiz, End Term
6	Classification of fluid flows	Able to classify and recognize the dominant parameters effecting fluid flow	Self-Study	1407.1	Home Assignment, End Term
7, 8, 9	Fluid statics: governing equation, pressure and its distribution	Derive the governing eqn, and Determine the variation of Pressure in a fluid at rest.	Lecture	1407.1	In Class Quiz, End Term
10, 11	Pressure measuring devices, manometery, Hydrostatic forces on plane surfaces	Calculate pressure using various kinds of manometers and forces , moments exerted by a fluid at rest on plane surfaces	Lecture	1407.1, 1407.2	Class Quiz, Mid Term I, End Term
12	Hydrostatic forces on curved surfaces	Calculate forces, moments exerted by a fluid at rest on curved surfaces	Activity (Think Pair Share)	1407.2	Class Quiz, Mid Term I, End term
13	Buoyancy and stability & Review of Fluid Statics	Analyze the stability of floating and submerged bodies	Self -Study	1407.2	Home Assignment, Class Quiz,Mid Term 1,End Term
14	Fluid Kinematics: Lagrangian and Eulerian description	Understand importance of Material derivative and concept of Lagrangina and Eulerial description of fluid flow	Activity	1407.2	Class Quiz Mid Term I, End Term

15	Flow visualization techniques	Distinguish between various types of flow visualizations and methods		1407.2	Class Quiz Mid Term I, End Term
16	Reynolds transport theorem and Total Derivative	DerivationofRTTandunderstand its importance	Lecture	1407.3	Class QuizEnd Term
17,18	Conservation equations in fluid flow: Integral and differential form	Understand differential equations of Conservation of mass andlinear momentum Andtheirintegral from	Lecture	1407.3	Class Quiz, Mid Term II, End Term
19, 20	Bernoulli Equation:derivationandapplications	UnderstandtheuseandlimitationoftheBernoulliequation, and apply it to solve a variety of fluid flow problems	Lecture	1407.3	Class Quiz, Mid Term II, End Term
21	Review of fluid Kinematics	Review of concepts learned	Tutorial	1407.21 407.3	Class QuizMid Term IIEnd Term
22,23, 24	Control Volume analysis of flow systems	Identify the various kinds offorces andmoments acting on acontrolvolumeandthendeterminethe forces associatedwith fluid flow	Lecture	1407.4	Class QuizMid Term IIEnd Term
25,26	DimensionalAnalysisandsimilarity:Dimensional HomogeneityandPiTheorem	Developunderstandingofdimensionalhomogeneity and itsbenefits.	Lecture	1407.4	Class Quiz, End Term
27	Non-dimensionalizationofgoverningequations	Able to nondimensionalize adifferential equation	Lecture	1407.4	Class Quiz, End Term
28	models and prototype testing	Understand the concept ofmodel and prototype similarityand apply it to experimentalmodelling	Lecture	1407.4	Class Quiz, End Term

29	Review Numerical Practice	Review of concepts learned	Tutorial	1407.4	Class Quiz, End Term
30	Internal flow: viscous flow in ducts	Concept of developed anddeveloping flows in ducts,boundary layer etc	Lecture	1407.4	Class Quiz End Term
31	Reynolds number, laminar and turbulent Flows	Understand difference b/wlaminar and turbulent flowsin ducts	Lecture	1407.4 1407.5	Class Quiz End term
32, 33	Plane Poiseuille flow,Hagen-Poiseulleflows	Solution of NSE for simpleconfigurations	Lecture	1407.4	Class Quiz
34	**losses in pipe network**	Major andminorlossesassociated with pipesandpiping networks	Lecture	1407.4 1407.5	Class Quiz, Mid Term II, End Term
35, 36	**Flow measurement devices and their Principles**	Understandflowmeasurement techniques anddevices	Lecture	1407.4 1407.5	Class Quiz, Mid Term II, End Term
37	**External flow: flow over flat plate**	Understanding of physicalphenomena associated withexternal flows	Lecture	1407.4	Class Quiz, Mid Term II,End Term
38	**Flow past bluff bodies**	Concept of drag, pressure force, lift	Lecture	1407.4	Class Quiz, End Term
39	**Concept of drag and lift**	continued	Lecture	1407.4 1407.5	Class Quiz, End Term
40	**Review of internal and external flows**	review	Tutorial	1407.4 1407.5	Class Quiz, End Term
41, 42	**Fluid machines: pumps and turbines**	Identify various types of pumps,turbines, and understand howthey work	Lecture	1407.6	Class Quiz, End Term

43	**Characteristic curves**	Understand and read characteristiccurves for hydraulic machines			Lecture	1407.6	Class Quiz, End Term
44	**Scaling laws**	Understand various scaling laws, applicable to hydraulic machines			Lecture	1407.6	Class Quiz, End Term
45, 46	**Turbines**	Perform basic vector analysis offlow into and out of pumps andturbines			Lecture	1407.6	Class Quiz,End Term
47,48	**Review of fluid mechanics**	review			Tutorial		

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	PSO 3
MC1407.1	To describe the static and dynamic fluid systems using respective governing equations.	1										1				0
MC1407.2	Devise simple solutions to a range of problemsin basic fluid flow	2	2	1			1					2		1	2	1
MC1407.3	To apply concepts of mass, momentum and energy conservation to flows	1		3	2	2										1
MC1407.4	To able to analyze variety of simplified flow problems theoretically	2			2	2				1		1				1
MC1407.5	Grasp the basic ideas of turbulence	1		1				1		1	1				1	1
MC1407.6	Identify various types of pumps and turbines andknow their working principles	2	1	1									1		1	1
							1-LowCorrelation; 2- Moderate Correlation; 3-Substantial Correlation									

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Computer Aided Drawing Lab| MC 1430 | 1 Credits | 0 0 2 1

Session: Jan 18 – May 18 | Faculty: Mohit Jain | Class: B. Tech IV Sem

P. Introduction: This course is offered by Dept. of Mechatronics Engineering as a lab, targeting students who wish to learn design machine parts of a machine, robotic link and mechanism. It includes 2D and 3D modelling of machine parts.

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

[1331.5]. Create technically correct surface and solid models that are common to and useful for visualization and problem solving in design and robotics engineering disciplines using various design software programs such as AutoCad

[1331.6]. Create technical presentations of models from mechanical and design engineering disciplines in both technically correct and visually pleasing solid, orthographic, and section view formats

[1331.7]. Produce project design documentation using modeling skills in project-based assignments using Auto Cad and Creo

[1331.8]. Coordinate design and mechanical engineering models into the design development process

R. 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]. Apply the knowledge of basic sciences, analytical skills, and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 any time 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	

S. Syllabus

Introduction: Modelling Using Pro Engineer; Protrusion, shell; Revolve, sweep; Chamfer, fillet, hole, parallel blend; Rotational blend Sketcher, rotational pattern, reference pattern, Part Assembly; Finite Element Analysis using ANSYS: 2D spur 2D beam element; 2D solid element, 2D thermal element; Shell element; 3D sold element

T. Reference Books

R1. I. Zeid, CAD/CAM Theory and Practice 2ED, 2nd edition, McGraw Hill Education, 2012

R2. Pro E wildfire 4.0/creo 2.0, 2013

U. Lecture Plan:

	Name of the Experiment	Experiment Outcome	Type of Expt.	Corresponding CO	Mode of Assessing the Outcome
2, 3	Introduction to Autocad Commands	Understanding about basics	Hands-on	1430.3	Observational Data, Viva-Voce
	Assignment problem based on 2D drawings Assignment -1 based on Circle, Drag mode, Arc, Ellipse, And Donut commands	Understanding about different commands need to draw line diagrams	Hands-on	1430.3	Observational Data, Viva-Voce
	Assignment -2 and 3 based on the Erase, Redraw, and Move, Copy and transparent commands and object selection	Understanding about few more additional feature of commands	Hands-on	1430.3	Observational Data, Viva-Voce
	Assignment -4 based on patterns.	Learn to draw simple 2D drawings	Hands-on	1430.3	Observational Data, Viva-Voce
	Assignment -5 based on patterns.	Learn to draw complex 2D drawings	Hands-on	1430.3	Observational Data, Viva-Voce
	Assignment -6 based on Dtext, Style and Mtext commands	Learn for few more complex commands	Hands-on	1430.3	Observational Data, Viva-Voce
	Assignment -7 based on Ddunits, Limits and Status commands, Aperature, Osnap, and Ddosnap commands Assignment -8 based on Stretch, Scale, Rotate, Trim, Extend, and Lengthen commands	Learn for few more complex commands	Hands-on	1430.3	Observational Data, Viva-Voce
2	3D modelling using AutoCad	Learn 3D drawing basics	Hands-on	1430.3	Observational Data, Viva-Voce
	Assignment -9 based on 3D Primitives	Learn simple 3D drawings	Hands-on	1430.3	Observational Data, Viva-Voce
	Assignment -10 based on 3D Primitives	Learn simple 3D drawings	Hands-on	1430.3	Observational Data, Viva-Voce
	Assignment -11 and 12 based on 3D Primitives	Learn few more complex 3D drawings	Hands-on	1430.3	Observational Data, Viva-Voce

V. 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
430.1	Create technically correct surface and solid models that are common to and useful for visualization and problem solving in design and robotics engineering disciplines using various design software programs such as AutoCad				1										1	
430.2	Create technical presentations of models from mechanical and design engineering disciplines in both technically correct and visually pleasing solid, orthographic, and section view formats				1										1	
430.3	Produce project design documentation using modelling skills in project-based assignments using Auto Cad and Creo			3										2	1	
430.4	Coordinate design and mechanical engineering models into the design development process					1								1	1	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Integrated Electronics Lab | MC1431 | 3 Credits | 3 0 0 3

Session: Jan 2018 – May 2018 | Faculty: Mr. Prabhat Ranjan | Class: B. Tech. IV Semester

Introduction: This course is offered by Dept. of Mechatronics Engineering as a lab, targeting students who wish to pursue research & development in industries or higher studies in field of chip design, PCB design, logic circuits, electronic circuitry etc. Offers hands-on experience on varied logic circuits and integrated chip testing boards.

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

[1431.1].	Identify relevant information to supplement to the Digital System Design course
[1431.2].	To understand the basic digital circuits and to verify their operation
[1431.3].	Construct basic combinational circuits and verify their functionalities
[1431.4].	Apply the design procedures to design basic sequential circuits

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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

Syllabus

Regulator using 78XX and LM 317.Digital circuit design, combinational circuits – Implementation of Boolean functions and Arithmetic circuits, Multiplexers and implementation of circuits using multiplexers, Decoders and implementation of circuits using decoders, code converters, display driver interfaces, ripple counters, shift registers and ring counters, synchronous counters.

Text Books:

1. Donald D. Givone, Digital Principles and Design, Tata McGraw Hill Publications, 2002.

2. Morris Mano, Digital design, Prentice Hall Publishers, 4

th edition, 2007.

3. D. Stanley William, Operational Amplifiers with Linear Integrated Circuits, Prentice Hall

2004.

References:

1. David J. Comer, Digital Logic State Machine Design, Oxford University Press, 3rd edition.

2. A. Ananda Kumar, Switching Theory and Logic Design, Prentice Hall of India Publishers,

2009.

Lecture Plan:

Lab No	**Name of the Experiment**	**Experiment Outcome**	**Type of Expt**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Study of Implementation of Logic Gates .	To acquaint and clear queries regarding Implementation of Logic Gates .	HandsOn	NA	NA
2	Study of Implementation of Arithmetic Circuits.	To acquaint with basic assembly programming	HandsOn	1431.1 1431.2	Observational Data, Viva-Voce
3	Design, build and test simple combinational circuits using logic gates like NAND and NOR	To acquaint with direct addressing in assembly programming	HandsOn	1431.3	Observational Data, Viva-Voce
4	Code converters Circuit	To acquaint with loop programming	HandsOn	1431.2 1431.4	Observational Data, Viva-Voce
5	Magnitude Comparator and Parity Checker/Generator (Odd/even parity)	To acquaint indirect addressing in assembly programming	HandsOn	1431.1	Observational Data, Viva-Voce
6	Multiplexers and De-multiplexers	To acquaint with basic arithmetic operations	HandsOn	1431.2	Observational Data, Viva-Voce

7	Encoders and Decoders	To acquaint with basic arithmetic operations and complex instructions	HandsOn	1431.5	Observational Data, Viva-Voce
8	Flip Flops	To acquaint with basic arithmetic operations and complex instructions	HandsOn	1431.2	Observational Data, Viva-Voce
9	Study of IC 7474: Positive edge triggered dual D flip-flops with preset and clear	To acquaint with basic arithmetic operations and complex instructions	HandsOn	1431.3	Observational Data, Viva-Voce
10	Synchronous 4-bit up counter	To acquaint with short jump	HandsOn	1431.2	Observational Data, Viva-Voce
11	Ring Counter	To acquaint with long jump	HandsOn	1431.5	Observational Data, Viva-Voce
12	Design of SISO and SIPO register,	To understand about LCD operations and its programming	HandsOn	1431.3	Observational Data, Viva-Voce
13	Design of PISO and PIPO register,	To understand about stepper motor operations and its programming	HandsOn	1431.1 1431.5	Observational Data, Viva-Voce
14	Digital to Analog Converter	To understand about LED blinking operations and its programming	HandsOn	1431.3	Observational Data, Viva-Voce
15	Finite State Machine	To understand about seven segment display operations and its programming	HandsOn	1431.2	Observational Data, Viva-Voce
16	Revision	Revision of Experiments	HandsOn	1431.2	Observational Data, Viva-Voce

Z. 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	PSO 2	PSO3

MC1431.1	Identify relevant information to supplement to the Digital System Design course.	3	1	1	1	1								1		
MC1431.2	To understand the basic digital circuits and to verify their operation		2	1		3								1	2	
MC1431.3	Construct basic combinational circuits and verify their functionalities		2	1	2									2		
MC1431.4	Apply the design procedures to design basic sequential circuits		3	2	1	1								2	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile, Mechanical and Mechatronics Department of Mechatronics

Course Hand-out

[Organization and Management | BB1540 | 3 Credits |

Session: July– December 2017 | Faculty: Dr. Sunny Dawar | Class: Mechatronics V Semester 1

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 lifegiving 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 organization 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.

[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 Mid Term I 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 Mid Term I 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 Mid Term I 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 Mid Term II End Term
16.	Manpower Planning	Students will gain the knowledge of manpower planning	Lecture, Discussion	BB1540.2	Class Quiz Mid Term II 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 Mid Term II 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 to ensure 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)

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

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Control Systems | MC1507| 4 Credits | 4 0 0 4

Session: July 17 – Nov17 | Faculty: Dr. Ajay Kumar| Class: Core Subject

A. INTRODUCTION: This course is offered by Dept. of Mechatronics Engineering as a Program Elective. This course covers the analysis of linear systems and its stability using various techniques.

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

[ME1507.1] Describe the mathematical model of a system and understand the methods of representation of systems and to design their transfer function models.
[MC1507.2] Translate the Mechanical System to analogous Electrical System.
[MC1507.3] Describe feedback control in control systems.
[MC1507.4] Analyze the time response of systems and steady state error analysis and Interpret and differentiate the response of the different order systems for standard test input signals.
[MC1507.5] Demonstrate the methods of basic control system design, including time and frequency response. Analyze and test MATLAB programs to check the system stability to enhance employability skills

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 processesthat 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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, Power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	15
	Sessional Exam II (Closed Book)	15
	In class Quizzes and Assignment on MATLAB for designing any system Attendance	25 5
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. 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 classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS:

Block Diagrams and Signal flow graph: Transfer function, Block Diagram, Simplification of systems, Signal flow graphs, Gain formula, State diagram, Transfer function of discrete data systems (PTF), Zero order hold; System modeling: Modeling of electrical and Mechanical Systems (translational & Rotational), System equations, its electrical equivalent (analogous) networks; Time domain analysis: Stability, Routh-Hurwitz criterion, time response for Continuous data systems, type and order of systems, Steady state error for linear Systems, Unit step response for second order systems, Root locus properties and construction; Frequency domain analysis: Introduction, second order prototype system, Bode diagram, Gain and Phase margins, Nyquist stability criterion; Compensators and controllers: Proportional, Integral, PI, PD and PID controllers, Lead, Lag and Lead-Lag compensators; State space representation: Stability Analysis, State transition matrix, Eigen values, Controllability and Observability.

F. Text Books:

Ogata, K., Modern Control Engineering, Prentice-Hall, [2002]
Hsu, J. C. & A. U. Meyer, Modern Control Principles and Applications, McGraw-Hill, [1968]

G. Secondary References:

Gopal, M., Modern Control System Theory, John Wiley Eastern Ltd. New Delhi, [1984]
Friedland, B., Control System Design, McGraw-Hill, [1986]
M.Gopal , “Digital Control and State Variable Methods” , Tata McGraw Hill New Delhi , 2005
Kuo, B.C., “Digital Control Systems”, Oxford University press, 1992.
Ogata, K., State Space Analysis of Control Systems, Prentice-Hall, [1967]
Kuo, B. C., Automatic Control Systems, Prentice-Hall, [1987]
Slotine, J. E. & Weiping Li, Applied Nonlinear Control, Prentice-Hall, [1991]
Gibson, J. E., Nonlinear Automatic Control, McGraw-Hill, [1963]

Software:

MATLAB: Control and Simulink Tool Boxes, Math Works Inc.

H. Lecture Plan:

Lec. No	**Topics**	**Session Objective**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Introduction to feedback control system	To understand the importance of feedback systems	Lecture	CO.1& CO.2	In Class Quiz (Not Accounted)
3,4	Describe open loop and closed loop systems with examples	Few definitions for understanding closed loop systems	Lecture	CO.1 & CO.2	In Class Quiz
5,6	Introduction to block diagram representation	Physical meaning of the terms and its usage	Lecture	CO.2	Home Assignment
7.-10	Block Diagram Representation numerical Practice	To practice numerical on Block Diagram Representation	Lecture, Flipped Classroom	CO.3	In Class Quiz
11	Concepts of Signal Flow Graph	Study of Mason Gain Formula for closed loop systems		CO.3	Home Assignment Class Quiz
12-14	Modelling of Electrical, Mechanical Systems	Study of Modelling of a system	Lecture	CO.3	Class Quiz
15,16	Numerical Practice	Numerical Practice	Lecture	CO.3	Class Quiz
17	Introduction to Control System using MATLAB	Acquaint students with the brief overview of control system toolbox	Software Learning	CO.6	Class Quiz
18-19	Introduction to stability	To check for stability conditions by and analysing in MATLAB	Software Learning	CO.6	Class Quiz, Case Study
20	Different methods for finding stability	Acquaint students about different methods for finding stability	Flipped Classroom	CO.5	Class Quiz
21	Routh Hurwitz Criteria, Numerical Practice	Acquaint students about different methods for finding stability	Lecture	CO.5	Class Quiz

22-24	Time response Analysis	Time Response for continuous Systems	Lecture	CO.5	Class Quiz
25	Numerical Practice	Numerical Practice	Lecture	CO.5	Class Quiz
26	Bode Plot	Acquaint about another method for finding stability	Lecture	CO.5	Class Quiz
27-30	Root Locus and Bode plot Numerical Practice	Stability analysis	Lecture	CO.5	Class Quiz
31-32	Nyquist Criteria	Stability analysis	Lecture	CO.4	Home Assignment
33-35	Introduction to State space Analysis	To understand importance of state space analysis	Lecture	CO.4	Class Quiz
36	Introduction to PID Controller	Introduction about Controllers	Lecture	CO.3	Class Quiz
37	Revision	NA	NA, Flipped Classroom	NA	NA

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

CO	STATEMENT	CORRELTION 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 1660.1	Describe the mathematical model of a system and understand the methods of representation of system and to design their transfer function models	3	2			2								3	2	
ME 1660.2	Translate the Mechanical System to analogous Electrical System				2	3								2		
ME 1660.3	Describe feedback control in control systems.	1		3	3	2								2	3	
ME 1660.4	Analyze the time response of systems and steady state error analysis and Interpret and differentiate the response of the different order systems for standard test input signals.	2	2	2		3								2	1	
ME 1660.5	Demonstrate the methods of basic control system design, including time and frequency response. Analyze and test MATLAB programs to check the system stability.	3	1	1	2	3								3	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Mechatronics Systems Elements | MC 1508 | 4 Credits | 3 1 0 4

Session: July 17 – Dec 17 | Faculty: Prabhat Ranjan | Class: Core Subject

A. Introduction: This course is offered by Department of Mechatronics Engineering as a core subject, targeting students who wish to pursue research & development in industries or higher studies in field of Mechatronics. The course focuses on key elements of mechatronics system such as system modelling, sensors, actuators and control algorithms.

B. Course Objectives:

[1508.1]. Discuss the basic elements of a mechatronics system.
[1508.2]. Analyse different type of actuators such as relays, motors and their applications.
[1508.3]. Understand the working and application of various sensors.
[1508.4]. Design various type of signal conditioning systems for a mechatronics system.
[1508.5]. Design and implementation of a control algorithm in a mechatronics system.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 of mechatronic systems, needs and benefits of mechatronics in manufacturing, Sensors and Transducers: Displacement Sensor Strain - Strain gauges, Force/Torque, Motion & Velocity sensors, Proximity and Range sensors – Eddy current sensor, ultrasonic sensor, laser interferometer transducer, Hall Effect sensor, inductive proximity switch, Light sensors, phototransistors, Flow sensors, laser Doppler anemometer, tactile sensors, micro-switch & reed switch, Piezoelectric sensors, vision sensor, Drives and Actuators: Solenoids, relays, diodes, Thyristors, TRIACS, BJT, FET, DC motor, Servo motor, BLDC Motor, AC Motor, stepper motors, Piezoelectric actuators, Shape memory alloys, Hydraulic & Pneumatic devices, Power supplies, valves, cylinder sequencing, Data Acquisition & Translation: Signal conditioning, Multiplexer, Pulse width Modulation, Signal Analysis, Linearization of data, Compensation, Signal Averaging, Fourier analysis, Data Presentation System: Display - Cathode ray oscilloscope, LED, LCD, Printers, Magnetic Recording. Controllers and Algorithms: PID controller and controller tuning.

Text Books

T1. D. A. Bradley and others, Mechatronics, Chapman & Hall Publications.

T2. David G. Alciatore & Michael B Histand., Introduction to Mechatronics and Measurement systems, Tata McGraw Hill, 2003.

Reference Books

R1. Dan Nesculescu, Mechatronics, Pearson Education Pvt. Ltd, 2002

R2. C. R. Venkataramana, Mechatronics, Sapna Book house, Bangalore, 2001

F. Lecture Plan:

Lecture No.	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1,2	Introduction, Basic elements of MSE	To understand the basic elements of MSE	Lecture	1508.1	In Class Quiz Mid Term I End Term
3,4	Basics of Sensors and Transducers, Displacement Sensors	Understanding basics of sensors and working of displacement sensor	Lecture	1508.1 1508.3	In Class Quiz Mid Term I
5	Strain gauges	Analysis and application of stain gauge sensor	Lecture	1508.3	In Class Quiz End Term
6,7	Force/Torque measurement	Measurement methods of force/torque	Lecture	1508.3	Home Assignment End Term
8,9,10	Motion & Velocity sensors	Explain working of motion and velocity sensors	Lecture	1508.3	In Class Quiz End Term
11,12,13	Proximity and Range sensors,	Basics of proximity sensors and working of different type of sensors	Activity (Think Pair Share)	1508.3	Class Quiz Mid Term I End Term
14,15	Eddy current sensor,	Explain working of eddy current sensor	Lecture, Activity (Jigsaw)	1508.3	Class Quiz Mid Term 1 End term
16	ultrasonic sensor,	Describe the working and application of ultrasonic sensor	Lecture, Flipped Class	1508.3	Home Assignment Class Quiz Mid Term 1 End Term
17	laser interferometer transducer	Describe the working and application of laser interferometer transducer	Lecture, Activity (Think Pair Share)	1508.3	Class Quiz Mid Term 1 End Term
18	Hall Effect sensor,	Discuss the working of hall effect sensor	Lecture	1508.3	Class Quiz Mid Term I End Term
19,20	Light sensors	Discuss about different type of light sensors	Lecture	1508.3	Class Quiz End Term

21,22	Flow sensors, laser Doppler anemometer	Explain about flow sensors	Lecture	1508.3	Class Quiz Mid Term II End Term
23,24	tactile sensors	Application and working of tactile sensor	Lecture, Activity	1508.3	Class Quiz Mid Term II End Term

25,26	Piezoelectric sensors,	Analysis and working of piezoelectric sensor	Lecture, Activity	1508.3	Class Quiz Mid Term II End Term
27	vision sensor	Describe vision sensors	Lecture	1508.3	Class Quiz Mid Term II End Term
28,29	Relays, Solenoids,	Explain working of relays and solenoid	Lecture	1508.2 1508.1	Class Quiz Mid Term II End Term
30,31	diodes, BJT, FET, Thyristor, TRIAC	Describe the basics of solid state devices	Lecture	1508.1	Class Quiz End Term
32,33	DC motor	Explain working of dc motors	Lecture	1508.2	Class Quiz End Term
34	Servo motor	Modelling and working of servo motor	Lecture	1508.2	Class Quiz Mid Term II End Term
35	BLDC Motor	Describe working of BLDC motor	Lecture	1508.2	Class Quiz End Term
36,37	AC Motor	Explain working of AC motors	Lecture	1508.2	Class Quiz End term
38,39	stepper motors	Explain application and working of stepper motor	Lecture	1508.2	Class Quiz Mid Term II End Term
40,41	Piezoelectric actuators	Application of piezoelectric actuator	Lecture	1508.2	Class Quiz Mid Term II End Term
42	Shape memory alloys	Describe shape memory alloy	Lecture	1508.1	Class Quiz Mid Term II End Term

43,44	Hydraulic & Pneumatic devices, valves	Basics of valves	Lecture	1508.1	Class Quiz Mid Term II End Term
45	Power supplies	Basics of power supplies	Lecture	1508.1	Class Quiz
46	Basics of Signal conditioning, Current Feedback Operational amplifiers	Analysis of CFOA	Lecture	1508.4	End Term
47	Multiplexer, Pulse width Modulation	Describe PWM	Lecture	1508.4	Class Quiz
48	Signal Analysis, Linearization of data	Analysis to linearize the data	Lecture	1508.4	Class Quiz End Term
49	Compensation, Signal Averaging, Fourier analysis	Analysis of signals	Lecture	1508.4	Class Quiz

50	Data Presentation System: Display - Cathode ray oscilloscope, ,	Explanation of CRO	Lecture	1508.1 1508.5	Class Quiz Mid Term II End Term
51	LED, LCD Printers, Magnetic Recording	Explain the working of data presenting systems	Lecture	1508.1	Class Quiz End Term
52	PID Controller and Controller parameter tuning	Analysis and tunning of PID controller	Lecture	1508.5	Class Quiz End Term

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

CO	STATEMET	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	PSO 1	PSO 2	PSO 3
MC 1508 .1	Discuss the basic elements of a mechatronics system.	1	1	1	1								1	1	1
MC 1508 .2	Analyse different type of actuators such as relays, motors and their applications.	1	2	2	1		1						1	2	1
MC 1508 .3	Understand the working and application of various sensors.	1	2	2	1		1						1	2	1
MC 1508 .4	Design various type of signal conditioning systems for a mechatronics system.	1	2	2	1	1	1			1		1	1	3	1
MC 1508 .5	Design and implementation of a control algorithm in a mechatronics system.	1	2	3	3	1	2	1		1		1	1	3	1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Microprocessors and Microcontrollers| MC 1509 | 4 Credits | 3 1 0 4

Session: July 17 – Nov 17 | Faculty: Kumar Gaurav | Class: Dep. Core (V Sem)

W. Introduction: This course is offered by Dept. of Mechatronics Engineering as a department core, targeting students who wish to pursue research & development in industries or higher studies in field of systems built around microprocessors and microcontrollers. It is a step-by-step walk through basics and up-to design and development phase of the project based on the microprocessors and microcontrollers. Programming in assembly as well as Embedded C further add interest and strengthen the course which is of utmost need to program these processors/controllers. Microprocessors and microcontrollers are also used to control traffic lights, appliances, motion control, position control, servo control, elevators, automation, electric car and control of AC/DC machines. It is also used in measurement and display of electrical and physical quantities such as voltage, current, frequency, phase angle, stress, strain etc. In a nutshell this course will introduce the world of automated systems driven by microprocessors and microcontrollers.

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

[1331.9]. Assess and solve basic binary math operations using the microprocessor and explain the microprocessor's and Microcontroller's internal architecture and its operation within the area of manufacturing and performance.

[1331.10]. Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor and microcontroller.

[1331.11]. Compare accepted standards and guidelines to select appropriate Microprocessor (8085 & 8086) and Microcontroller to meet specified performance requirements.

[1331.12]. Analyse assembly language programs; select appropriate assemble into machine a cross assembler utility of a microprocessor and microcontroller.

[1331.13]. Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices.

[1331.14]. Evaluate assembly language programs and download the machine code that will provide solutions to real-world control problems and enhance employability skills.

Y. Program Outcomes and Program Specific Outcomes

[PO.25]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.26]. 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.27]. 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.28]. 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.29]. 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.30]. **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.31]. **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.32]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.33]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.34]. **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.35]. **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.36]. **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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

Z. 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 , mini projects, 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/ Mini Project/Activity Assignment (Formative)	There are situations where a student may have to work in home on a given problem. However, a student is expected to participate with full zeal and perform these assignments (Individually/Team) with graded marks and show the outcome.

AA. Syllabus

MICROPROCESSORS AND MICROCONTROLLERS: Introduction to microprocessor, History of Microprocessors, General block diagram of 8085, & 8086 with their instruction set. Introduction to microcontroller, History of Micro controllers, Embedded versus External memory devices, Microcontroller survey, CISC and RISC Microcontrollers, Harvard and von Neumann Architecture, Commercial Micro controller Devices, Introduction to 8051 family, History of 8051,Architectural features of 8051,Programming model. Pin details, I/O Ports, Power down operation, Addressing Mode, Instruction set of 8051 and Programming, Programming the 8051 resources, Counters, Timers, Serial Interface, Multiprocessor communication and Interrupts, Measurement of frequency, period and pulse width of a signal, Peripheral Interfacing- memory interfacing, Key board, LCD, stepper motor, Seven Segment Display, Digital to analog Converter, Analog to Digital converters, The 8051 based system design- case studies, Traffic light control, and Washing machine control, mining problem, Turbine monitor, Introduction to PIC Microcontrollers- Architectural and Peripheral features, ALU, CPU, Memory map, clock, pipelining, addressing and I/O ports.

BB. Text Books

T1. K. Kant, *Microprocessors and Micro controllers*, PHI learning publications, 2007.

T2. M. A. Mazidi, J. G. Mazidi, & R. D. Mckinlay, *8051 Microcontroller and Embedded Systems Using Assembly and C*, Pearson Education, 2010.

.

CC. Reference Books

R1. A.V. Deshmukh, *Micro controllers- Theory and Applications*, Tata McGraw Hill, New Delhi, 2008.

R2. J. A. Kenneth, *The 8051 Microcontroller Architecture, programming and applications*, Penram International Publications, Mumbai, 2008.

R3. *PIC micro Mid- Range MCU Family Reference Manual*.

DD. Lecture Plan:

Lec No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**
1	Introduction to class about course	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA
2	Introduction to microprocessor, History of microprocessors	Explain need of microprocessors/microcontrollers in daily life	Lecture	1509.1
3	General block diagram of 8085 & 8086	Discussion about different components of a computing system	Lecture	1509.1
3	Addition and subtraction in different Number system	Recall basics of number system, binary, decimal, hexadecimal etc.	Lecture	1509.1
4	Difference b/w a microprocessor and microcontroller	Difference between the two	Lecture	1509.1
5,6,7	Pin Diagram of 8085 microprocessor	Details pin diagram discussion	Lecture	1509.2 1509.5
8,9,10	Internal architecture of 8085	Register array description	Lecture	1509.6
11,12	Comparison of 8085 and 8086 and introduction to assembly level language	Basics of assembly level programming	Lecture	1509.2
13,14, 15	Instruction set of 8085	Arithmetic, logical, branch instructions	Lecture	1509.2 1509.3
16,17	Assembly level Programming for 8085	Practice problems		
18	CISC and RISC Microcontrollers, Harvard and von Neumann Architecture,	Difference between the two	Lecture	1509.2 1509.3
19	Interrupts in 8085	Discussion and problems		1509.3
20	Commercial Micro controller Devices	Microcontroller, discussion	Lecture	1509.2
21,22	Introduction to 8051 family, History of 8051	Discussion about other features of 8051	Lecture	1509.4
23,24,25,26	Architectural features of 8051	Details about architectural features and their interconnect	Lecture	1509.4
27	Programming model	Register array description	Lecture	1509.4 1509.3
28,29	Pin details, I/O Ports, Power down operation	Working features	Lecture	1509.4 1509.3
30	Addressing Mode of 8051	Category of instructions	Lecture	1509.4
31,32,33	Instruction set of 8051	Assembly level opcode details	Lecture	1509.4
34,35,36	Programming in 8051	Programming practice	Lecture	1509.5
37,38	Counters	Counter importance and its programming procedure	Lecture	1509.6 1509.5
39,40	Timers	Timer importance and its programming procedure	Lecture	1509.6 1509.3
41, 42	Serial Interface	Serial communication and its programming	Lecture	1509.2 1509.1
43	Measurement of frequency, period and pulse width of a signal,	Concept of frequency and pulse width with programming	Lecture	1509.4
44,45,46	Multiprocessor communication and Interrupts,	Interrupts in 8051 microcontroller and their importance	Lecture	1509.5 1509.3

47	The 8051 based system design- case studies, and Washing machine control	Practical application	Lecture	1509.6
48	Traffic light control,	Practical application	Lecture	1509.6
49	mining problem, Turbine monitor,	Practical application	Lecture	1509.6
50	Introduction to PIC Microcontrollers-, Architectural and Peripheral features	PIC Microcontrollers	Lecture	1509.1 1509.2
51	ALU, CPU, Memory map, clock, pipelining	Their relevance in PIC Microcontrollers	Lecture	1509.1 1509.3
52	Addressing and I/O ports	Discussion in brief about addressing modes	Lecture	1509.1 1509.2
53	Revision	NA	NA	

EE. 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
MC 1509.1	Assess and solve basic binary math operations using the microprocessor and explain the microprocessor's and Microcontroller's internal architecture and its operation within the area of manufacturing and performance	3		2		2		2		2				3	1	1
MC 1509.2	Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor and microcontroller	2		2		2	3		1	1				1	2	
MC 1509.3	Compare accepted standards and guidelines to select appropriate Microprocessor (8085 & 8086) and Microcontroller to meet specified performance requirements.	2	2		2		3	1			1	1	2	2	1	
MC 1509.4	Analyse assembly language programs; select appropriate assemble into machine a cross assembler utility of a microprocessor and microcontroller	3		3		2			1	1	1			3	1	
MC 1509.5	Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices.	2	2	2	2	3	2	1			1		1	1	3	

MC 1509.6	Evaluate assembly language programs and download the machine code that will provide solutions real-world control problems.			2		3				2		1		1	3	1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Lab Course Hand-out

Microprocessors and Microcontroller Lab| MC 1532 | 1 Credits | 0 0 2 1

Session: July 17 – Nov 17 | Faculty: Mr. Kumar Gaurav | Class: B. Tech V Sem

FF. Introduction: This course is offered by Dept. of Mechatronics Engineering as a lab, targeting students who wish to pursue research & development in industries or higher studies in field of Automation Engineering, including Embedded systems, Robotics, and other advanced systems. Offers hands-on experience on varied Microprocessors and Microcontrollers testing boards.

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

[1331.15]. Identify relevant information to supplement to the Microprocessor and Microcontroller course.
[1331.16]. Set up programming strategies and select proper mnemonics and run their program on the training boards.
[1331.17]. Practice different types of programming keeping in mind technical issues and evaluate possible causes of discrepancy in practical experimental observations in comparison.
[1331.18]. Develop testing and experimental procedures on Microprocessor and Microcontroller and analyse their operation under different cases.
[1331.19]. Prepare professional quality textual and computational results, incorporating accepted data analysis and synthesis methods, simulation software, and word-processing tools to enhance employability skills

HH. 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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

II. 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	

JJ. Syllabus

Introduction to 8085 trainer kit and instruction set, Programming for Arithmetic and Logic operations, Array sorting, Code conversion, generate & sum of Fibonacci series, display of message. Introduction to 8051 simulation software and familiarization of 8051 instruction set, Arithmetic and Logic related programs, Array handling and code conversion programs, I/O port and Timer/ Counter programming, Programming using 8051 trainer kit in serial mode, DAC

Interfacing Programs, Keyboard and LCD Interface, Analog to Digital converter Interface, Seven segment Interfacing Programs, Logic Controller Interfacing Programs, Stepper motor Interfacing Programs, DC motor interface.

Text Books:

1. K. Kant, Microprocessors and Micro controllers, PHI learning publications, 3rd edition, 2007.

2. M. A. Mazidi, J. G. Mazidi, & R. D. Mckinlay, 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, 2nd edition, 2010.

KK. Lecture Plan:

Lab No	Name of the Experiment	Experiment Outcome	Type of Expt	Corresponding CO	Mode of Assessing the Outcome
1	Demonstration Program	To acquaint and clear teachers expectations and understand student expectations	Live Demo	NA	NA
2	Addition of 'n' numbers in an array	To acquaint with basic assembly programming	HandsOn	1532.1 1532.2	Observational Data, Viva-Voce
3	Code conversion	To acquaint with direct addressing in assembly programming	HandsOn	1532.3	Observational Data, Viva-Voce
4	Generate sum of Fibonacci series and factorial of 8 bit number	To acquaint with loop programming	HandsOn	1532.2 1532.4	Observational Data, Viva-Voce
5	Separation of hexadecimal number into two digits and Combination of two hex nibbles to from one byte number	To acquaint indirect addressing in assembly programming	HandsOn	1532.1	Observational Data, Viva-Voce
6	Addition of two 16-bit numbers using 8086 microprocessor	To acquaint with basic arithmetic operations	HandsOn	1532.2	Observational Data, Viva-Voce
7	Multiplication of two 16-bit number	To acquaint with basic arithmetic operations and complex instructions	HandsOn	1532.5	Observational Data, Viva-Voce
8	Experiment 7: Hexadecimal Addition and subtraction of two 8 bit numbers.	To acquaint with basic arithmetic operations and complex instructions	HandsOn	1532.2	Observational Data, Viva-Voce
9	Experiment 8: Hexadecimal division and multiplication	To acquaint with basic arithmetic operations and complex instructions	HandsOn	1532.3	Observational Data, Viva-Voce
10	Experiment 9: To find the even or odd number	To acquaint with short jump	HandsOn	1532.2	Observational Data, Viva-Voce
11	Experiment 10: Logical operations	To acquaint with long jump	HandsOn	1532.5	Observational Data, Viva-Voce
12	Experiment 11: Flashing characters on LCD screen	To understand about LCD operations and its programming	HandsOn	1532.3	Observational Data, Viva-Voce
13	Experiment 12: Stepper motor interfacing	To understand about stepper motor operations and its programming	HandsOn	1532.1 1532.5	Observational Data, Viva-Voce
14	Experiment 13: LED Blink Interfacing	To understand about LED blinking operations and its programming	HandsOn	1532.3	Observational Data, Viva-Voce

15	Experiment 14: Seven segment display interfacing	To understand about seven segment display operations and its programming	HandsOn	1532.2	Observational Data, Viva-Voce
16	Experiment 15: Buzzer interfacing	To understand about buzzer interfacing operations and its programming	HandsOn	1532.2	Observational Data, Viva-Voce

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

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES									
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
MC1532.1	Identify relevant information to supplement to the Microprocessor and Microcontroller course.	3	1	1	1	1			1		
MC1532.2	Set up programming strategies and select proper mnemonics and run their program on the training boards.		2	1		3					
MC1532.3	Practice different types of programming keeping in mind technical issues and evaluate possible causes of discrepancy in practical experimental observations in comparison.		2	1	2						
MC1532.4	Develop testing and experimental procedures on Microprocessor and Microcontroller and analyse their operation under different cases.		3	2	1	1					
MC1532.5	Prepare professional quality textual and computational results, incorporating accepted data analysis and synthesis methods, simulation software, and word-processing tools to enhance employability skills			1	1		1		2	1	1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Sensor and control lab| MC 1533 | 1 Credits | 0 0 2 1

Session: July 17– Nov 17 | Faculty: OP Gujela| Class: A. Tech VSem

Introduction:

This course is offered by Dept. of Mechatronics Engineering as a lab, targeting students who wish to pursue research & development in industries or higher studies in field of Mechatronics Engineering, including hydraulics and pneumatics circuit design electrical drive control and power electronics. This lab consists of different types of industrial grade proximity sensors and hydraulic actuators with different accessories which provides learning platforms enhancing knowledge about the industrial automation and there applications. Also a portable, comprehensive and practical way to learn Technology has also been provided. More than 50 experiments can be performed with the help of sensors and actuators provided by the Bosch-Rexroth. The sensor part consist of comprises of sensors and transducers which provide the fundamental knowledge of sensing light, pressure, temperature, IR and many more non electrical entities.

The hydraulic part of this lab consists of different hydraulic actuators, control valves for displacement and direction control (mechanical and electromechanical).Different hydraulic circuits can be formed and tested with or without the application of PLC. The industrial automation can be visualized in this lab.

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

[MC1533.1] Understand the principle of operation of various sensors and their behaviour for different types of industrial material.

[MC1533.2] Implementation of different sensors for various applications in Industrial automation.

[MC1533.3] Design the basic control system models and verify it mathematically.

[MC1533.4] Apply different input conditions and observe the response of various control system models using Matlab Simulink Environment.

NN. 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]. Apply the knowledge of basic sciences, analytical skills, and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 any time 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

OO. Syllabus

Design of fluid power circuit to control a double action cylinder for displacement velocity, force and direction, Design of an electro pneumatic circuit to control a double acting cylinder, Application of hydraulic simulation software based on cad system, to designControl circuits for automated functioning, Application of pneumatic simulation software based on Cad systemfor design of control circuits for automated functioning, Application of servo motor using PLC for controller interface and servo operation, Application of DCmotor using PLC position control and speed control, Application of software for driving stepper motor in full step resolution mode,half step resolution mode and milli step resolution mode, Use of Robotic trainer to study characteristics of proximitysensing and vision sensing, Use of Robotic trainer to study the methods of achieving speed control,displacement control, in two and three dimensional space with reference to six degrees of freedom.

PP. Reference Book:

1. Bradley, Mechatronics, Chapman & Hall Publications, 2002.2.D.G.
2. Alciatore& M. B.Histand., Introduction to Mechatronics and Measurement systems, Tata McGraw Hill, 3rdedition, 2003.
3. Shetty & R. Kolk, Mechatronics System Design, PWS Publishers, 2ndedition, 2010
4. D. Nesculescu, Mechatronics, Pearson Education Pvt. Ltd, 1stedition, 2002.
5. R. Venkataramana,Mechatronics, Sapna Book house, Bangalore,2ndedition,2001.

QQ.Lecture Plan:

Lab No	**Name of the Experiment**	**Experiment Outcome**	**Type of Expt.**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	A. Behavior of inductive sensors NBN B. Behavior of capacitive sensors CJ C. Behavior of magnetic field sensors MB	Understanding about SCR working	Hands-on	1533.1	Observational Data, Viva-Voce
2	A. Behavior of the reflection light scanner OJ B. Behavior of one-way light barriers C. Behavior of the reflection light barrier OBS	Effect of control signal on output waveform	Hands-on	1533.1	Observational Data, Viva-Voce
3	Behavior of an ultrasonic sensor	Effect of control signal on output waveform	Hands-on	1533.1	Observational Data, Viva-Voce
4	Switching distance and hysteresis of the inductive sensor NBN	Effect of control signal on output waveform	Hands-on	1533.2	Observational Data, Viva-Voce
5	Reduction factor of the inductive sensor NBN	Effect of control signal on output waveform	Hands-on	1533.2	Observational Data, Viva-Voce

6	Response curve of the inductive sensor NBN	Effect of control signal on output waveform	Hands-on	1533.2	Observational Data, Viva-Voce
7	Detection of smaller objects with one-way light barrier (optical waveguide ELG and reflection light scanner OJ) and background suppression.	Effect of control signal on output waveform	Hands-on	1533.2	Observational Data, Viva-Voce
8	Effects of different input signals in a RC circuit using MATLAB Simulink and block modeling.	Speed control implementation	Hands-on	1533.3	Observational Data, Viva-Voce
9	Effects of different input signals in a RLC circuit using MATLAB Simulink and block modeling	Speed control implementation	Hands-on	1533.4	Observational Data, Viva-Voce
10	Mathematical modeling of a servo motor and the computer simulation of a servo motor Using MATLAB Simulink.	Effect of load on drive characteristics	Hands-on	1533.3	Observational Data, Viva-Voce
11	To Mathematically model a Cruise Control and the computer simulation of a Cruise Control Using MATLAB Simulink.	Effect of load on drive characteristics	Hands-on	1533.4	Observational Data, Viva-Voce
12	To Mathematically model an Oscillation Dampener and the computer simulation of an Oscillation Dampener Using MATLAB Simulink.	Effect of load on drive characteristics	Hands-on	1533.4	Observational Data, Viva-Voce

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

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES									
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
MC1533.1	Understand the principle of operation of various sensors and their behaviour for different types of industrial material.	2	3	0	1	0	1	0	0	0	0
MC1533.2	Implementation of different sensors for various applications in Industrial automation.	2	3	1	0	0	0	0	0	0	0
MC1533.3	Design the basic control system models and verify it mathematically.	2	2	0	1	0	0	0	0	0	0
MC1533.4	Apply different input conditions and observe the response of various control system models using Matlab Simulink Environment.	1	2	0	2	0	2	1	0	0	0

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Signals and systems| MC1550 | 3 Credits | 3 0 0 3

Session: July 17 – Nov 17 | Faculty: O. P. Gujela | Class: Prog. Elective (V Sem)

SS. Introduction: Signal processing is an extremely important tool in a wide variety of engineering domains. This course is introduced in mechatronics course to provide the basic concepts and theories related to analog and digital signal processing. The course is intended to impart knowledge on signal transformation techniques and its application. The prerequisites are calculus, basics of complex numbers, and some exposure to differential equations. Prior exposure to the fundamentals of circuits for electrical engineers or fundamentals of dynamics for mechanical engineers is helpful but not essential.

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

[1331.20]. To classify different types of signals and perform basic time domain operations on them
[1331.21]. To perform time domain transformations and operations on various signal types
[1331.22]. To perform frequency domain transformations and operations on various signal types
[1331.23]. To implement and verify signal transformation algorithms using software tools in MATLAB and python
[1331.24]. To interpret practical problems with knowledge of signals and systems

UU. 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 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 the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

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

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

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

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering 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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

VV. 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.	

WW. Syllabus

Introduction to signals and systems: Definitions, Overview of specific systems, Classification of signals, Basic operations on signals, Elementary signals and functions, Systems viewed as interconnections of operations, properties

of systems. Time domain representations for **linear time-invariant systems**: Introduction, Convolution: Impulse response representation for LTI systems, properties of the impulse response representation for LTI systems, Differential and difference equation representations for LTI systems, Block diagram representations. Fourier representation for signals: The **discrete-time Fourier series**, continuous-time periodic signals: The Fourier series, Discrete-time non-periodic signals: The discrete-time Fourier transform, **continuous-time non-periodic signals**: The **Fourier transform**, properties of Fourier representations, Discrete-time periodic signals, **Fast Fourier transform**. **Z-transform** and its applications: Review of z-transform, unilateral z-transform, solution of difference equations, Analysis of LTI system in z-domain-system function, pole-zero analysis, stability

XX. Text Books

T1. A.V. Oppenheim, A. S. Willsky & A. Nawab, *Signals and Systems*, 2nd edition, PHI. /Pearson Education, New Delhi, 1996.

Reference Books

R1. S. Haykin & B. V. Veen, *Signals and Systems*, John Wiley &Sons, New Delhi, 2nd edition, 2002.
R2. J.G. Proakis, D.G. Manolakis, D. Mimitris, *Introduction to Digital Signal Processing*, Prentice Hall, India, 4th Edition, 2006.
R3. A.V. Oppenheim & R.W. Schafer, *Discrete Time Signal Processing*, Pearson education, 3rd Edition, 2011.

YY. 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 signals and systems	Basic idea of what is signals and systems	Lecture	1550.1	In Class Quiz (Not Accounted)
3-6	Continuous and discrete time signals and their properties	Thorough concept different types of signals and properties related to that	Lecture	1550.1	In Class Quiz Sessional exam I End Term
7,8	Convolution	Understand the Mathematics and physical significance of convolution	Lecture	1550.2	Home Assignment Sessional exam I End Term
9,10	Linear time invariant systems	Understanding of properties of LTI systems	Lecture, flipped class	1550.1 ,1550.2	In Class Quiz Sessional exam II End Term
11,12,13	Continuous time fourier series	Analysis of mathematical background and application of CTFS	Lecture, Activity	1550.2, 1550.3	Class Quiz Sessional exam II End term
14,15	Continuous time fourier transform	Analysis of mathematical background and application of CTFT	Lecture, Activity	1550.2, 1550.3	Home Assignment Class Quiz Sessional exam II End Term
16,17	Discrete time fourier series	Analysis of mathematical background and application of DTFS	Lecture, Activity	1550.2, 1550.3	Class Quiz Sessional exam II End Term
18,19	Discrete time fourier transform	Analysis of mathematical background and application of DTFT	Lecture, Activity	1550.2, 1550.3	Class Quiz Sessional exam II End Term
20	Filtering	Introduction to different filtering methods	Lecture	1550.2, 1550.3	Class Quiz End Term
21-25	Software implementation	Use of MATLAB and python in signal processing	Lecture, activity	1550.4	Class Quiz End Term
26 - 28	The laplace transform	Analysis of mathematical background and application of Laplace transform	Lecture	1550.2, 1550.3	Class Quiz Mid Term II End Term
29 - 32	Z-transform	Analysis of mathematical background and application of Z-transform	Lecture	1550.2, 1550.3	Class Quiz End Term
33, 34	Pole-zero analysis	System analysis with pole and zero placements	Flipped class	1550.2, 1550.3	Class Quiz End Term

35, 38	Case studies	Application of signals of systems in practical simulations	Activity	1550.4, 1550.5	Class Quiz End Term
39, 40	Case studies	Theoretical analysis of practical cases	Lecture, flipped class	1550.4, 1550.5	Class Quiz End Term

ZZ. 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
MC 1550.1	To classify different types of signals and perform basic time domain operations on them	3				1								1	2	
MC 1550.2	To perform time domain transformations and operations on various signal types	2	3											2	2	
MC 1550.3	To perform frequency domain transformations and operations on various signal types	1	1			3								3	3	
MC 1550.4	To implement and verify signal transformation algorithms using software tools in MATLAB and python	1	2	2		1								3	3	
MC 1550.5	To interpret practical problems with knowledge of signals and systems		3	1						2		1	2	2	2	

10. Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Materials Science| MC 1551 | 3 Credits | 3 0 0 3

Session: July 17 – Nov 17 | Faculty: KKM Pandey | Class: Programme Elective

Introduction: Crystal Structures, computations of packing factor of cubic and HCP structure, Solidification, nucleation and crystal growth, dendritic growth, Phases in solids, Equilibrium diagrams (only binary), construction and explanation of isomorphous and eutectic systems, equilibrium and non-equilibrium cooling, Equilibrium and non-equilibrium cooling of an alloy, Iron-Carbon systems, Heat treatment, continuous cooling curves isothermal transformation diagram, Ferrous-alloys.

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

[MC1551.1] Develop the basic fundamental of material science and engineering
[MC1551.2] Discover the different classes of material their properties, structures and imperfections **present in them.**
[MC1551.3] Understanding the behavior of materials, particularly structure-property correlation.
[MC1551.4] Identify the limits of materials and the change of their properties with use.
[MC1551.5] Value the use the material for different application and their processing

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.

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 any quiz test will have to report to the instructor about the absence in advance. A makeup assignment will be given to the student.	
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.	

Syllabus

Introduction: Material Science and human civilization. Impact of material on progress- transport, aspects of failure and Electronics revolution. **Material Science and Engineering:** Atomic structure and bonding.**Crystal Structures**: computations of packing factor of cubic and HCP structure, co-ordination number, Miller indices, crystal imperfections-point & line defects. Solidification: degree of super cooling, homogeneous & heterogeneous nucleation. Mechanism of solidification , nucleation and crystal growth, dendritic growth, **Phases in solids**: Phases-Single phase and multiphase, Gibb's phase rule, Solid solutions and types, Intermediate phases, Equilibrium diagrams (only binary), construction and explanation of isomorphous and eutectic systems, equilibrium and non-equilibrium cooling, invariant reactions Lever rule and its application on isomorphous and eutectic systems, Equilibrium and non-equilibrium cooling of an alloy, congruent melting alloy phase and super lattices, Iron-**Carbon systems**: cooling curve for pure iron, types of Fe-C equilibrium diagrams, study of iron-carbon system in detail with emphasis on the invariant reactions, Heat treatment: Principle heat treatments, isothermal transformation diagram- Construction and explanation, factors affecting shape and position of isothermal transformation diagram, continuous cooling curves isothermal transformation diagram, processes like annealing, normalizing, hardening, tempering and case hardening with heat treatment cycle, Jominy hardness test, Ferrous-alloys: Composition, properties and applications of alloy steels

Text Books:

1. Callister, *Materials Science and Engineering*, Wiley, 2nd edition, 2014.

2. Yu. Lakhtin, *Engineering Physical metallurgy and heat treatment*, MIR Publishers, Moscow, 1985.

3. V. Raghavan, *Material Science and Engineering*, Prentice Hall of India, Delhi, 5th edition ,2007.

F. Reference Books:

1. R. A. Higgins, *Engineering Metallurgy*, ELBS Publications, London, 5th edition, 1983.

2. S. H. Avner, *Introduction to Physical Metallurg*, Tata McGraw Hill, New Delhi, 3rd edition, 2004.

3. H. Lawrence, Van

AAA. Lecture Plan:

Lec No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Material Science and human civilization	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Impact of material on progress	Explaining effect of materials on automobiles	Lecture	1551.1	In Class Quiz(Not Accounted)
3	Material Science evolution	Learning basic components of atomic structure and bonding.	Lecture	1551.1	In Class Quiz End Term
5	Crystal Structure	Define the term arrangement, lattice and symmetry.	Lecture	1551.1	End Term
6	Crystal Structure	Explain arrangement, lattice and symmetry.	Activity (Think Pair Share)	1551.1 1551.2 1551.3	In Class Quiz End Term
7,8	Crystal Direction	Acquire knowledge on miller indices planes and systems.	Activity (Think Pair Share)	1551.2 1551.3	Class Quiz Mid Term I End Term
9	Coordination No.	Able to calculate the arrangement of atoms	Lecture	1551.2 1551.3	Class Quiz Mid Term 1 End term
10	Atomic Packing factor	Finding out packing factor for applications.	Lecture	1551.2 1551.3	Home Assignment Class Quiz Mid Term 1 End Term
11	Planar density	Understanding the structure of materials	Lecture	1551.2 1551.3	Class Quiz Mid Term 1 End Term
12	Linear density	Understanding the structure of materials	Activity (Think Pair Share)	1551.2 1551.3	Class Quiz Mid Term I End Term
13	Closed packed structure	Understanding the structure of materials	Lecture with PPT	1551.2 1551.3 1551.4	Class Quiz End Term
14,15	Structure property co-relation, Polycrystalline and non –crystalline crystal	Development of fundamentals of structure and its relation to properties.	Lecture/ Activity (Think Pair Share)	1551.2 1551.3	Class Quiz Mid Term II End Term
16	Grain size determination and relationship	Development of fundamentals of structure and its relation to properties.	Lecture/ Case Study	1551.1 1551.2	Class Quiz Mid Term II End Term
17	Nano materials	Consolidation of knowledge on nano materials and their segregation and preparation.	Lecture/ Case Study	1551.1 1551.2	Class Quiz Mid Term II End Term
18	Dislocation movement	Identifying the importance of defects.	Lecture/	1551.3 1551.4	Class Quiz Mid Term II End Term

19	Surface defect	Identifying the importance of defects	Lecture/	1551.3 1551.4	Class Quiz End Term
20	Lattice defect	Identifying the importance of defects	Lecture/	1551.3 1551.4	Class Quiz End Term
21	Bulk or volume defect	Identifying the importance of defects	Lecture	1551.3 1551.4 1551.5	Class Quiz End Term
22	Solid solution	Discover aspects of solids and their behaviour in different conditions.	Lecture	1551.5 1551.4	Class Quiz End Term
23	Phase diagram	Value the use of different materials and their applications.	Lecture	1551.3 1551.4 1551.5	Class Quiz End Term
24	Phase diagram	Value the use of different materials and their applications.	Lecture	1551.4 1551.5	Class Quiz End term
25	Phase diagram	Value the use of different materials and their applications.	Lecture/ Activity (Think Pair Share)	1551.4 1551.5	Class Quiz
26	Phase Transformation	Value the use of different materials and their applications.	Lecture	1551.4 1551.5	Class Quiz Mid Term II End Term
27	Phase Transformation	Value the use of different materials and their applications.	Lecture/ Activity (Think Pair Share)	1551.2 1551.3	Class Quiz Mid Term II End Term
28,29	Phase Transformation	Value the use of different materials and their applications.	Lecture/ Activity (Think Pair Share)	1551.4 1551.5	Class Quiz Mid Term II End Term
30,31	Phase Transformation	Value the use of different materials and their applications.	Lecture/ Activity (Think Pair Share)	1551.1 1551.2 1551.3	Class Quiz End Term
32,33	Heat Treatment	Develop concepts of producing different material for different applications.	Lecture/ Activity (Think Pair Share)/Case Study	1551.1 1551.2 1551.3	Class Quiz End Term
34,35	Heat Treatment	Develop concepts of producing different material for different applications.	Lecture/ Activity (Think Pair Share)/Case Study	1551.1 1551.2 1551.3 1551.5	Class Quiz End Term
36,37	Heat Treatment		Lecture/ Activity (Think Pair Share)/Case Study	1551.1 1551.2 1551.3 1551.5	Class Quiz End Term
38	Conclusion	NA	NA		NA

BBB. 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
MC1551.1	Develop the basic fundamental of material science and engineering	2	2							1				1	1	
MC1551.2	Discover the different classes of material their properties, structures and imperfections present in them.		3	1	1										2	2
MC1551.3	Understanding the behavior of materials, particularly structure-property correlation.					3		1	1	1	1		3	1	1	
MC1551.4	Identify the limits of materials and the change of their properties with use.		1	2	2	1		1								2
MC1551.5	Value the use the material for different application and their processing	1	1	2	1			1	1					1	1	1

10. Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering

Course Hand-out

Manufacturing Process| MC1552 | 3 Credits | 3 0 0 3

Session: July 17 – Nov 17 | Faculty: Dr. Manish Rawat | Class: Prog. Elective

A. Introduction: This course is offered by Dept. of Mechatronics Engineering as a Prog. Elective, targeting students who wish to pursue research& development in industries or higher studies in field of smart machining. Manufacturing involves the transformation of raw materials from their initial form into finished, functional products. Man achieves this transformation by numerous methods utilising a variety of processes each designed to perform a specific function in the transformation process. Inherent in the design and operation of processes must be a knowledge of the properties of engineering materials and specific methods to utilise these properties during the various stages of the manufacturing process. Because of the competitive nature of the manufacturing industry, engineers are constantly striving to create new materials, better transformation methods and processes which are cheap to operate, efficient, fast and accurate. This course provides an introductory study of manufacturing processes and is complemented by further studies at higher levels of the program. Various material forming and cutting processes are considered, and theoretical knowledge is reinforced by practical demonstrations and videos.

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

[1552.1] Examine the principles associated with basic operations involving the casting, machining and welding of engineering materials.

[1552.2] Interpret the advantages and limitations of each process and its influence on the properties of the material in the finished component;

[1552.3] Interpret the geometry of tooling used on various metal cutting machines;

[1552.4] Analyse the practical applications of a variety of forming and machining processes

[1552.5] Analyse the effects of heat, lubrication and various cutting tool materials on the metal cutting process.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Rubrics:

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 (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

Metal Casting Process: Classification of metal casting, Pattern Allowances, Molding Materials, Gating system design. Casting defects: Causes and remedies, Inspection of castings Introduction to Machine Tools: Classification of machine tool, Mechanics of Metal Cutting: Principles of metal machining, cutting tools and tool materials, tool signature, mechanics of chip removal, tool wear, tool life, economics of machining. Metal Joining Processes: Principle of welding, soldering, Brazing and adhesive bonding. Classification of welding and allied processes. Resistance welding: Spot, Projection and seam welding process, Atomic hydrogen, ultrasonic, Plasma and laser beam welding, Electron beam welding, and special welding processes e.g. TIG, MIG, friction and explosive welding. Metal Shaping and Forming: Metal working, Elastic and plastic deformation, Hot and cold working, Rolling, Principle and operations, Forging, Forging operations, extrusion, Wire and tube drawing processes. Forging: Principle of forging tool design, Cold working processes: Shearing, Drawing Squeezing, Blanking, Piercing, deep drawing, Coining and embossing.

F. Text Books

T1. S. Kalpakjian, and S. R. Schmid, Manufacturing Engineering and Technology, Pearson Education, 6th Edition, 2009.

T2. A. Ghosh, and A. K. Malik, Manufacturing Science, Affiliated East West Press Pvt. Ltd., 2nd Edition, 2010.

G. Reference Books

R1. P.C. Sharma, A text book of Production Technology. S. Chand and Company, 4th Edition, 2006.

R2. P. N. Rao, Manufacturing Technology Volume-1 and II, Tata McGraw-Hill Education, 4th Edition, 2013.

H. Lecture Plan:

Lec No	**Topics**	**Session Objective**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction	Examine the principles associated with basic operations involving the casting, machining and welding of engineering materials.	Lecture	CO.1	NA
2	Metal Casting Process: An Introduction	Examine the principles associated with basic operations involving the casting, machining and welding of engineering materials.	Flipped Classroom	CO.1	In Class Quiz (Not Accounted)
3,4	Classification of metal casting, Pattern Allowances, Molding Materials	Examine the principles associated with basic operations involving the casting, machining and welding of engineering materials.	Lecture	CO.1	In Class Quiz
5,6	Gating system design	Examine the principles associated with basic operations involving the casting, machining and welding of engineering materials.	Lecture	CO.1	End Term
7.8	Casting defects: Causes and remedies	Examine the principles associated with basic operations involving the casting, machining and welding of engineering materials.	Lecture	CO.1	Home Assignment
9	Casting defects: Causes and remedies and Inspection of castings	Examine the principles associated with basic operations involving the casting, machining and welding of engineering materials.	Lecture	CO.1	End Term
10	Introduction to Machine Tools: Classification of machine tool,	Interpret the geometry of tooling used on various metal cutting machines;	Lecture	CO.1I	
11	Introduction to Machine Tools: Classification of machine tool,	Analyse the effects of heat, lubrication and various cutting tool materials on the metal cutting process.	Flipped Class	CO.V	In Class Quiz

12	Mechanics of Metal Cutting: Principles of metal machining, mechanics of chip removal,	Analyse the effects of heat, lubrication and various cutting tool materials on the metal cutting process.	Lecture	CO.V	End Term
13	Mechanics of Metal Cutting: Principles of metal machining, mechanics of chip removal,	Analyse the effects of heat, lubrication and various cutting tool	Flipped Class	CO.V	Class Quiz
		materials on the metal cutting process.			
14	Mechanics of Metal Cutting: Principles of metal machining, mechanics of chip removal,	Analyse the effects of heat, lubrication and various cutting tool materials on the metal cutting process.	Lecture	CO.V	Mid Term I
15,16	Tool signature,	Interpret the geometry of tooling used on various metal cutting machines;	Lecture	CO.1I	End Term
17	Tool wear and Tool life,	Interpret the advantages and limitations of each process and its influence on the properties of the material in the finished component;	Lecture, Activity	CO.1I	Class Quiz
18	Economics of machining.	Interpret the geometry of tooling used on various metal cutting machines;	Lecture, Activity	CO.1I	Mid Term 1
19	Metal Joining Processes: An Introduction	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	End term
20	Principle of welding, soldering, Brazing and adhesive bonding.	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	Home Assignment
21	Classification of welding and allied processes.	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	Class Quiz
22	Arc Welding Process	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	Mid Term 1
23	Resistance welding: Spot, Projection and seam welding process,	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	End Term

24	Atomic hydrogen,	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	Class Quiz
25	Ultrasonic welding process	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	Mid Term 1
26	Plasma and laser beam welding,	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	End Term
27	Electron beam welding,	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	Class Quiz
28,29	Special welding processes e.g. TIG, MIG, friction and explosive welding.	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	Mid Term I
30,31	Metal Shaping and Forming: Principle and operations, Forging, Forging operations, Forging:	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	End Term
32,33	Metal working, Elastic and plastic deformation, Hot and cold working, Rolling,	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	Class Quiz
34,35	Extrusion, Wire and tube drawing processes.	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	End Term
36, 37	Principle of forging tool design,	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	Class Quiz
38	Cold working processes: Shearing, Drawing Squeezing, Blanking,	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	
39	Piercing, deep drawing, Coining and embossing.	Analyse the practical applications of a variety of forming and machining processes.	Lecture	CO.III and IV	End Term
40	Case Base Study-I		NA		Class Quiz
41	Case Base Study-I		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
MC1552.1	Examine the principles associated with basic operations involving the casting, machining and welding of engineering materials.	3							1					2		3
MC1552.2	Interpret the advantages and limitations of each process and its influence on the properties of the material in the finished component;		2	2								2		2		3
MC1552.3	Interpret the geometry of tooling used on various metal cutting machines;				2	2								2		3
MC1552.4	Analyse the practical applications of a variety of forming and machining processes						2		2					2		3
MC1552.5	Analyse the effects of heat, lubrication and various cutting tool materials on the metal cutting process.			1						1	1			2		3

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Pneumatics & Hydraulics Systems| MC 1605 | 3 Credits | 3 0 0 3

Session: Jan 18 – May 18 | Faculty: Varun J | Class: Core (VI Semester)

CCC. Introduction: This course is offered by Dept. of Mechatronics Engineering as a department core course, targeting students who wish to pursue research& development in industries or higher studies in field of Automation. Pneumatics has long since played an important role as a technology in the performance of mechanical work. It is also used in the development of automation solutions. In the majority of applications compressed air is used for one or more of the functions such as to determine the status of processors (sensors), information processing (processors), switching of actuators by means of final control element and carrying out work (actuators). To be able to control machinery and installations necessitates the construction of generally complex logic interconnections of statuses and switching conditions. This occurs as the result of the interaction of sensors, processors, control elements and actuators in pneumatic or partly pneumatic systems.

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

[MC1605.1] Describe the importance of fluid power and depict the use of different valves and circuit for achieving desired motion in automation.

[MC1605.2] Interpret and illustrate the working of valves or designing a circuit.

[MC1605.3] Experiment using different valves for circuit, analyse the outcome motion of circuit and correlate with working of valves, calculate motion of actuators as per time and modify the circuit using different valves to control the final actuator motion.

[MC1605.4] Recognize different circuit designing techniques and judge the best way to achieve the output with circuit for a particular condition of automation.

[MC1605.5] Recall different automated motion for different types of applications, choose and test various valves for the circuit developed to imitate actual motion required for automation.

EEE. Program Outcomes and Program Specific Outcomes

[PO.37]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.38]. 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.39]. 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.40]. 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.41]. 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.42]. 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.43]. **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.44]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.45]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.46]. **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.47]. **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.48]. **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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

FFF. 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.

GGG. Syllabus

Introduction to Fluid Power: Hydraulics and Pneumatics, Fluid power and fluid transport system, advantages, disadvantages and applications. Components: functions and properties of Hydraulic fluid, Pascal's law application, hydraulic power, siphon effect. **Hydraulic components**: losses in valves and fittings, hydraulic circuit analysis, pumping theory, classification of pumps, Volumetric displacement and flow rate for gear, vane and axial piston pump, performance and selection. Cylinder: construction and mountings, force, velocity and power, cylinder load due to moving weight and cylinder loadings. Motors: types, torque, power and flow rate, performance. Valves: DC valves, check, pilot, 3-way, 4-way, manually, mechanically and solenoid actuated valves, shuttle valve, Twin pressure valves, Shuttle valves ,Servo valves, Pressure control valves Pressure relief valve, pressure reducing valve, pressure compensation valve, symbols of valves. **Hydraulic Circuits**: with different components and objectives, hose size calculations. **Pneumatics:** Compressor types, capacity ratings, sizing of receiver, FRL, sizing of valves, actuators- cylinders and motors. Circuits: design considerations, air losses in pipe lines**. Pneumatic circuit analysis**. .Circuit design: Motion diagram, Cascading method, Karnaugh –Veitch method, electrical controls in pneumatic circuits.

HHH. Text Books

T1. S. R. Majumdar, Pneumatic Systems Principles and Maintenance, Tata McGraw Hill, New Delhi, 1st edition, 2000.

III. Reference Books

R1. P. Croser, F. Ebel, Pneumatics Basic Level TP 101, Festo Didactic GMBH & Co, Germany, 2nd edition, 2002.

R2. G. Prede and D. Scholz, Electro-pneumatics Basic Level, Festo Didactic GMBH & Co, Germany, 1st edition, 2002.

R3. J. P. Hasebrink and R. Kobler, Fundamentals of Pneumatic Control Engineering, Festo Didactic GMBH & Co, Germany, 1st edition, 2002

R4. W. Deppert and K. Stoll, Pneumatic Control, VOGEL Buchverlag Wurzburg Publications, Germany, 3rd edition,1992.

JJJ. 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	Hydraulics and Pneumatics	Explaining what fluid power is, difference b/w Pneumatics and Hydraulics and their applications	Lecture	1605.1	In Class Quiz (Not Accounted)
3	Fluid power and fluid transport system, advantages, disadvantages and applications.	Learning basic components of fluid power system and appreciating the scope of fluid power.	Lecture	1605.1	In Class Quiz End Term
5	Components: functions and properties of Hydraulic fluid, Pascal's law application, hydraulic power, siphon effect.	Define the term fluid, appreciate the desired properties of fluid. Study of pressure and pressure laws	Lecture	1605.1 1605.2	End Term
6	**Hydraulic components:** losses in valves and fittings,	Calculate frictional losses in valves and fittings, Using factor for finding out friction	Activity (Think Pair Share)	1605.1 1605.3	In Class Quiz End Term
7,8	Hydraulic circuit analysis, pumping theory	Perform an energy analysis of a complete hydraulic circuit.	Activity (Think Pair Share)	1605.1 1605.4	Class Quiz Mid Term I End Term
9	Classification of pumps, Volumetric displacement and flow rate	Able to identify pumps	Lecture	1605.1	Class Quiz Mid Term 1 End term
10	Gear, vane and axial piston pump, performance and selection	Able to select pumps based on the requirement for the circuit	Lecture	1605.1	Home Assignment Class Quiz Mid Term 1 End Term
11	Cylinder: construction and mountings, force, velocity and power	Recall types of cylinders and mountings and the force generated by them in various conditions	Lecture	1605.1 1605.2	Class Quiz Mid Term 1 End Term
12	Cylinder load due to moving weight and cylinder loadings	Recall types of cylinders and mountings and the force generated by them in various conditions	Activity (Think Pair Share)		Class Quiz Mid Term I End Term
13	Motors: types	Recall Types of motors available for hydraulic circuit and identification of the same	Lecture with PPT	1605.1	Class Quiz End Term

14,15	Torque, power and flow rate, performance for motors	Analyse motors for their performance and decide their output for the circuit.	Lecture/ Activity (Think Pair Share)	1605.2 1605.3	Class Quiz Mid Term II End Term
16	Valves: DC valves, check, pilot,	Identify and examine different valves used in the circuit and their applications	Lecture/ Demonstration	1605.1 1605.5	Class Quiz Mid Term II End Term
17	3-way, 4-way, manually, mechanically and solenoid actuated valves,	Identify and examine different valves used in the circuit and their applications	Lecture/ Demonstration	1605.1 1605.5	Class Quiz Mid Term II End Term
18	Shuttle valve, Twin pressure valves, Shuttle valves	Identify and examine different valves used in the circuit and their applications	Lecture/ Demonstration	1605.1 1605.5	Class Quiz Mid Term II End Term
19	Servo valves, Pressure control valves Pressure relief valve, pressure reducing valve,	Identify and examine different valves used in the circuit and their applications	Lecture/ Demonstration	1605.1 1605.5	Class Quiz End Term
20	Pressure compensation valve, symbols of valves	Identify and examine different valves used in the circuit and their applications, also to draft circuit as per the standards laid down by the industry.	Lecture/ Demonstration	1605.1 1605.5	Class Quiz End Term
21	**Hydraulic Circuits:** with different components and objectives	Describe the operation of complete hydraulic circuits drawn using graphic symbols for all components and analyse hydraulic circuit for the safety of operations	Lecture	1605.1 1605.2 1605.4	Class Quiz End Term
22	**Hydraulic Circuits:** with different components and objectives	Describe the operation of complete hydraulic circuits drawn using graphic symbols for all components and analyse hydraulic circuit for the safety of operations	Lecture	1605.1 1605.2 1605.4	Class Quiz End Term
23	**Hydraulic Circuits:** with different components and objectives	Describe the operation of complete hydraulic circuits drawn using graphic symbols for all components and analyse hydraulic circuit for the safety of operations	Lecture	1605.1 1605.2 1605.4	Class Quiz End Term
24	**Hydraulic Circuits:** with different components and objectives	Describe the operation of complete hydraulic circuits drawn using graphic symbols for all components and analyse hydraulic	Lecture	1605.1 1605.2 1605.4	Class Quiz End term

		circuit for the safety of operations			
25	Hose size calculations.	Determine the required wall thickness of a conductor to prevent bursting under operating fluid pressure.	Lecture/ Activity (Think Pair Share)	1605.1 1605.2 1605.4	Class Quiz
26	**Pneumatics:** Compressor types,	Identify different types of compressors and selection	Lecture	1605.1	Class Quiz Mid Term II End Term
27	Capacity ratings, sizing of receiver	Calculate the power required to drive compressors to satisfy system requirements and determine the size of receivers for meeting system pressure and flow –rate requirements.	Lecture/ Activity (Think Pair Share)	1605.1 1605.2 1605.4	Class Quiz Mid Term II End Term
28,29	FRL, sizing of valves, actuators- cylinders and motors	Understanding the working of FRL unit and determine how the flow rate of air can be controlled by valves	Lecture/ Activity (Think Pair Share)	1605.1 1605.2 1605.4	Class Quiz Mid Term II End Term
30,31	Circuits: design considerations, air losses in pipe lines Pneumatic circuit analysis.	Determine pressure losses in pipe line of pneumatic circuit and read pneumatic circuit diagrams and describe the corresponding system operation	Lecture/ Activity (Think Pair Share)	1605.1 1605.4 1605.5	Class Quiz End Term
32,33	Circuits: design considerations, air losses in pipe lines Pneumatic circuit analysis	Determine pressure losses in pipe line of pneumatic circuit and read pneumatic circuit diagrams and describe the corresponding system operation	Lecture/ Activity (Think Pair Share)	1605.1 1605.4 1605.5	Class Quiz End Term
34,35	**Circuit design:** Motion diagram, Cascading method,	To evolve o methodical pneumatic circuit diagram	Lecture/ Activity (Think Pair Share)	1605.1 1605.4 1605.5	Class Quiz End Term
36,37	Karnaugh –Veitch method, electrical controls in pneumatic circuits.	To evolve o methodical pneumatic circuit diagram	Lecture/ Activity (Think Pair Share)	1605.1 1605.4 1605.5	Class Quiz End Term
38	Conclusion and Course Summarization	NA	NA		NA

KKK. 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
[MC1605 .1]	Describe the importance of fluid power and depict the use of different valves and circuit for achieving desired motion in automation.	3	2	1										2		
[MC1605 .2]	Interpret and illustrate the working of valves or designing a circuit.	3	1	2	3										2	
[MC1605 .3]	Experiment using different valves for circuit, analyse the outcome motion of circuit and correlate with working of valves, calculate motion of actuators as per time and modify the circuit using different valves to control the final actuator motion.	3	1	1	3									2		
[MC1605 .4]	Recognize different circuit designing techniques and judge the best way to achieve the output with circuit for a particular condition of automation.	2	1	1	2									1	2	
[MC1605 .5]	Recall different automated motion for different types of applications, choose and test various valves for the circuit developed to imitate actual motion required for automation.	1	2											1	1	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering Course Hand-out

Programmable Logic Control| MC1606 | 3 Credits | 3 0 0 3

Session: Jan 18 – May 18 | Faculty: Anil Sharma | Class: Sixth Semester

A. **Introduction:** This course is offered by Dept. of Mechatronics Engineering as sixth semester subject, targeting students who wish to pursue research & development in industries or higher studies in field of Mechatronics Engineering, including Industrial Automation and control systems. Programmable Logic Controllers are now widely used throughout different types of industries. In this course students will learn about the basic principles of PLC control, different input devices (sensors and transducers), and typical output devices (actuators). Students will have hands on experience with different industrial processes. This course will provide the information required to make knowledgeable decisions about PLC applications in various manufacturing environments and industries. This course will allow for students to make well-informed decisions about existing control applications and to determine what is required for future applications.

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

[MC1606.1] Identify different types of logical process used in industrial automation.

[MC1606.2] Understand and connect the different switches, sensors and actuators with PLC.

[MC1606.3] Classify and comprehend the working principle of various industrial processes such as traffic light control and bottle filling plant.

[MC1606.4] Understand the advance programming concepts of PLC.

[MC1606.5] Provide the information required to make knowledgeable decisions about PLC applications in various manufacturing environments and industries.

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

[PSO.1]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 6 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.

C. SYLLABUS

Programmable Logic Controllers (PLCs) Introduction Parts of PLC Principles of operation PLC sizes PLC hardware components I/O section Analog I/O section Analog I/O modules, digital I/O modules CPU Processor memory module Programming devices Diagnostics of PLCs with Computers, PLC programming Simple instructions Programming EXAMINE ON and EXAMINE OFF instructions Electromagnetic control relays Motor starters Manually operated switches Mechanically operated and Proximity switches Output control devices Latching relays PLC ladder diagram Converting simple relay ladder diagram in to PLC relay ladder diagram, Timer instructions ON DELAY timer and OFF DELAY timer counter instructions Up/Down counters Timer and Counter applications program control instructions Data manipulating instructions math instructions, Applications of PLC Simple materials handling applications Automatic control of warehouse door Automatic lubricating oil supplier Conveyor belt motor control Automatic car washing machine Bottle label detection Process control application, PID control of continuous processes, Networking of PLCs, Controlling a robot with a PLC, PLC data move, jump functions, SKIP and MCR function, PLC arithmetic, number comparison, PLC Installation, troubleshooting and maintains.

D. TEXT BOOKS:

1. Frank D. Petruzella, *Programmable Logic Controllers*, McGraw- Hills Publications, 2004.

E. REFERENCE BOOKS:

1. William I. Fletcher, *an Engineering Approach to Digital Design*, Prentice Hall of India Publishers, New Delhi, 1999.
2. Chareles H. Roth, *Fundamentals of Logic Design*, Fourth Edition, Jaico Publishing house, 1999.
3. Frank D. Petruzella, *Programmable Logic Controllers*, McGraw- Hills Publications, 1989.
4. Reis & Reis, *Programmable Logic Controllers*, 5th edition, PHI Learning Publications, 2002.

F. Lecture Plan:

Lecture S.no.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
L1	**Introduction**, Basics of Programmable Logic	To acquaint and clear teachers expectations and understand student expectations	Lecture	**NA**	**NA**
L2	Introduction to PLC and its parts	Understand the need of PLC in industries, basics of automation and industry standards	Lecture	CO.1, CO.5	In class quiz
L3	Principle of operation of PLC - I		Lecture	CO.1, CO.5	In class quiz
L4	Principle of operation of PLC - II		Lecture	CO.1, CO.5	Class test
L5	PLC hardware description	To know about the hardware structure of different PLCs	Lecture	CO.1, CO.5	Class test
L6	PLC hardware description, PLC sizes		Lecture, Presentation	CO.1, CO.5	Class test
L7	Analog and digital input output modules	Understand the different modules of PLC and interaction with sensors and actuators	Lecture, presentation	CO.2	Home assignment
L8	Analog and digital input output modules		Lecture, presentation	CO.2	Home assignment
L9	Diagnostics of PLCs with computer	Understand "how to interface computers with PLC"	Lecture, presentation	CO.2	Class test
L10	Introduction to PLC programming	Know different programming environment for PLC	Lecture, presentation	CO.1	Class test
L11	Basics of ladder programming	Understand the basics of ladder programming	Lecture	CO.1	In class quiz
L12	Different operations using ladder programming		Lecture, presentation	CO.1	In class quiz
L13	Control of relays using PLC	To know the working and interface of different input switches used in automation industries	Presentation	CO.2	Class test
L14	Manually operated switches		Presentation	CO.2	Class test
L15	Mechanically operated and proximity switches		Lecture, presentation	CO.2	Class test
L16	Output control devices - I	To know the working and interface of output devices and relays used in automation industries	Lecture, presentation	CO.2	Home assignment
L17	Output control devices - II		Presentation	CO.2	Home assignment
L18	Latching relays		Presentation	CO.2	
L19	PLC diagram converting simple relay ladder diagram into PLC relay ladder diagram	Know the programming structure of Ladder with practical examples	Lecture	CO.1	In class quiz

L20	PLC diagram converting simple relay ladder diagram into PLC relay ladder diagram - II		Lecture	CO.1	In class quiz
L21	Timer instruction - Introduction		Lecture	CO.1	Class test
L22	PLC programming using Timer instructions	Understand the timing instructions required for programming in PLC	Lecture, presentation	CO.1	Class test
L23	Counter - Introduction	Know "how to use counter" for real time practical application	Lecture	CO.4	Class test
L24	Counter instructions Up/Down counter		Lecture, presentation	CO.4	Class test
L25	Timer and Counter application program control instructions	Understand how to use timer and counter in a single program	Lecture	CO.4	Class test
L26	Data manipulating instructions	To know the advance instructions of PLC	Lecture, presentation	CO.4	Class test
L27	Math instructions	To know the advance instructions of PLC and use in programming environment	Lecture, presentation	CO.4	Class test
L28	Application of PLC, simple material handling applications - I	Work with real time problems in automation	Flipped classroom	CO.1, CO.3	Project demonstration
L29	Application of PLC, simple material handling applications - II		Flipped classroom	CO.1, CO.3	Project demonstration
L30	Automatic door control using PLC	Understand some of the practical problems and applications in automation industry and their solutions	Lecture	CO.1, CO.3	Project demonstration
L31	Automatic lubricating oil supplier Conveyor belt control		Lecture, flipped classroom	CO.1, CO.3	Project demonstration
L32	Motor control using PLC		Lecture	CO.1, CO.3	Project demonstration
L33	Automatic car parking system, Washing machine		Lecture, flipped classroom	CO.1, CO.3	Project demonstration
L34	Process control application of PLC		Lecture	CO.1, CO.3	Project demonstration
L35	Numerical Questions Practice	Practice of concepts	presentation	CO.1, CO.3	In class quiz
L36	PID control of continuous processes	Understand the basic need of process control	Presentation	CO.1	In class quiz
L37	Networking of PLCs, Controlling a robot with PLC	Understand the communication protocols of PLC networking	Lecture, presentation	CO.1	In class quiz
L38	PLC data move, jump, skip and MCR functions	Learn about advance concepts of PLC	Lecture, presentation	CO.4	Class test

		programming and application			
L39	PLC arithmetic and number comparison	Learn about advance concepts of PLC programming and application	Lecture, presentation	CO.4	Class test
L40	PLC arithmetic and number comparison	Learn about advance concepts of PLC programming and application	Lecture, presentation	CO.4	Class test
L41	PLC installation and Trouble shooting	How to solve different problems encountered in hardware, software or communication problems in PLC	Presentation	CO.5	NA
L42	PLC installation and Trouble shooting, Revision		Presentation	CO.5	NA

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
MC1606.1	Identify different types of logical process used in industrial automation.	3	3	2	1	1							2	3	2	
MC1606.2	Understand and connect the different switches, sensors and actuators with PLC.	3		1	1	1	1					1	1	1		2
MC1606.3	Classify and comprehend the working principle of various industrial processes such as traffic light control and bottle filling plant.	1	3	1	1	1				1	1	1	1	1	1	
MC1606.4	Understand the advance programming concepts of PLC.	2	1	3	3	1						1	1	1	1	1
MC1606.5	Provide the information required to make knowledgeable decisions about PLC applications in various manufacturing environments and industries.	1			1		2	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 Mechatronics Engineering

Course Hand-out

Industrial Robotics | MC1607 | 4 Credits | 3 1 0 4

Session: Jan 18 – May 18 | Faculty: Nikhil Shrivas | Class: Departmental Core

A. Introduction:

This course is offered by Dept. of Mechatronics Engineering as a core course. This course is designed to give a clear understanding of the concepts underlying the industrial robotic design. Simple mathematical methods are preferred to design a mechanical kinematic and dynamic and programming of industrial robot.

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

[MC 1607.1] Outline the basics of robot structure, its classification, and specification and robot drive systems.
[MC 1607.2] Study of type of sensors, their construction and working principle and their application as per industrial robotic requirement.

[MC 1607.3] Study of robot motion analysis. To predict the position of robotic joint, links, gripper with desired input.

[MC 1607.4] Study of statics and dynamics of robotic arm using simple mathematical equations of dynamics.
[MC 1607.5] To learn what are the effects of PID and other robot control systems and how they help to control the robot position.

[MC 1607.6] To learn how the Passivity-Based Robust and Adaptive Control can help control the position of actuator.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I	10
	Sessional Exam II	10
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	10
	Laboratory Sessions	20

End Term Exam (Summative)	End Term Exam	50
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
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 of Robots, Types of Robots, Degrees of Freedom, Degrees of Movements, Robot Configuration, Definition and factor affecting the Control Resolution, Spatial Resolution, Accuracy and Repeatability; Specification of a robot; MTBF; MTTR;

Actuators & Sensors in Robot, Moire-Fringes technique; Robot Vision;

Rapid Review of Kinematics: Homogeneous Transformations, Forward and Inverse Kinematics, Jacobians.

Dynamics: Euler-Lagrange Equations of Motion, Properties of Robot Dynamics, Examples. Independent Joint Control: Actuator Dynamics,

PI/PID Control, Drive-Train Dynamics, Feedforward Control, Multivariable Control: Inverse Dynamics, Passivity-Based Robust and Adaptive Control.

F. Text Books

Yu Kozyhev, *Industrial Robots Handbook*, MIR Publications, 1985.

K. C. Jain, L. N. Aggarwal, *Robotics Principles and Practice*, Khanna Publishers, 1997.

G. Reference Books

M. P. Groover, *Cam and Automation*, Prentice Hall Publications, 1995.

P. A. Janakiraman, *Robotics and image processing*, Tata McGraw Hill, 1995.

Ganesh S Hegde, Industrial Robotics, University Science Press, 2009.

H. Lecture Plan:

Lec. No	Topics	Session Objective	Mode of Delivery	Corresponding CO	Mode of the Assessing Outcome
1-2	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
3-4	Definition of Robots, Types of Robots,	To understand definition and types of robots.	Lecture	CO.1	Home Assignment
5-7	Degrees of Movements, Robot Configuration,	Degrees of freedom of robot and configuration	Lecture/Flipped Class	CO.1	
8-9	Spatial Resolution, Accuracy and Repeatability	Need to know robot resolution, repeatability and accuracy with their importance	Lecture	CO.1	Class Quiz
10-11	Specification of a robot; MTBF; MTTR	How the specifications are important and helps to select the robot.	Lecture	CO.1	Home Assignment
13-16	Actuators & Sensors in Robot	Need to know what are the different actuators and sensors of IR	Lecture	CO.2	
17-22	Moire-Fringes technique; Robot Vision	To know what is robot vision	Lecture	CO.3	Home Assignment
23-25	Rapid Review of Kinematics: Homogeneous Transformations	To learn basics robot kinematics	Lecture/Flipped Class	CO.4	
26-30	Forward and Inverse Kinematics, Jacobians	Learn to calculate forward and Inverse kinematics	Lecture	CO.4	Home Assignment
31-34	Dynamics: Euler-Lagrange Equations of Motion,	Learn to calculate the Dynamics of IR	Lecture	CO.5	Class Quiz
35-37	Examples. Independent Joint Control: Actuator Dynamics	Learn to calculate the Dynamics of IR	Lecture	CO.5	
38-40	PI/PID Control, Drive-Train Dynamics, Feedforward Control,	How the robot position and orientation are	Lecture	CO.5	Home Assignment

		controlled using controllers.			
41-43	Multivariable Control: Inverse Dynamics	How the robot position and orientation are controlled using controllers in Inverse dynamics.	Lecture	CO.6	Class Quiz
44-45	Passivity-Based Robust and Adaptive Control.	To understand the importance of robust and adaptive control	Lecture	CO.6	

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

CO	STATEMENT	CORRELTION WITH PROGRAM OUTCOMES									
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO
MC1607.1	Outline the basics of robot structure, its classification, and specification and robot drive systems.	3	2			**2**					
MC1607.2	Study of type of sensors, their construction and working principle and their application as per industrial robotic requirement.	1			2	3					
MC1607.3	Study of robot motion analysis. To predict the position of robotic joint, links, gripper with desired input.	2		3	3	2					
MC1607.4	Study of statics and dynamics of robotic arm using simple mathematical equations of dynamics.	3	2	2		3					
MC1607.5	To learn what are the effects of PID and other robot control systems and how they help to control the robot position.	3		1		2					
MC1607.6	To learn how the PassivityBased Robust and Adaptive Control can help control the position of actuator.	2		1	2	3					

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering

Course Hand-out

Electrical Drives & Special Machines| MC 1608 | 3 Credits | 3 0 0 3

Session: Jan 18 – May 18 | Faculty: Ashok Kumar Kumawat | Class: VI Semester

A. Introduction: This course is offered by Department of Mechatronics Engineering as a core subject, targeting students who wish to pursue research & development in industries or higher studies in field of power electronics and drive control. The course focuses on providing an introduction of different power semiconductor devices, different kind of power modulators and control mechanism for AC and DC machines. Students are expected to have background knowledge on drive control using power electronic circuits for a better learning.

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

[1608.1]. Describe the construction and working operation of power electronic devices such as SCR, IGBT etc.

[1608.2]. Analysis and working operation of various types of converters such as dc-dc, ac-ac, ac-dc, dc-ac.

[1608.3]. Ability to understand the components of electrical drives and dynamics of electrical drives.

[1608.4]. Develop design knowledge on how to design the speed control loops for DC Motor and AC motor.

[1608.5]. Ability to develop about selection criteria of motor power ratings.

[1608.6]. To learn about working and applications of special motors.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems. **[PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 semiconductor devices: SCR, GTO, IGBT, etc. **Electric Motors**: **DC Motors:** construction, principle, types, speed-torque characteristics, starting, speed control, **AC Motors:** Asynchronous motors: review of Induction Motors; Synchronous Motors: construction, principle, types, starting, speed control, **Electric Drives:** Components of electric drives, factors affecting choice of drives, dynamics of electrical drives, fundamental torque equation, speed-torque conventions, multiquadrant operation of electric drives, load torque components, nature and classification of load torque, equivalent moment of inertia, steady state stability, load equalization; Determination of motor power rating, motor duty cycles; Electric braking, **Power**

Modulators: Power semiconductor switches: power diodes, SCR, power transistor, IGBT, MOSFETs; Power converters: ac to

ac, ac to dc, dc to ac, dc to dc. **Special Machines:** Stepper Motors, Brushless DC Motors, Permanent Magnet Synchronous Motor, Synchronous Reluctance Motors, Universal Motors, Linear motors – LIM, LSM.

F. Text Books

T1. G. K. Dubey, Fundamentals of Electric Drives, Narosa publications, 2nd edition, 2001.

T2. Power Electronics: Circuits, Devices and Applications, Pearson Education, 2014

G. Reference Books

R1. I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw Hill, New Delhi, 4th edition, 2010.

R2. J. D. Edwards, Electrical Machines and Drives, Macmillan publications, UK, 3rd edition, 1991.

R3. P.S. Bimbhra, Power Electronics, Khanna Publishers, 2012

H. Lecture Plan:

Lec No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of the Assessing Outcome**
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2-4	Power Diode, Power Transistor, Power MOSFET	Understand the working operation of power devices	Lecture	1608.1	In Class Quiz Mid Term 1 End Term
5	Working and characteristics of IGBT	Advantages of IGBT over MOSFET	Lecture	1608.1	Home Assignment End Term
6-8	Working and characteristics of Power SCR, GTO	To learn the working operation of SCR	Lecture	1608.1	Class Quiz Mid Term I End Term
9-13	Power converter basics , AC to DC converter, AC to AC converter, DC to DC converter, DC to AC converter	To develop the designing knowledge of power modulators and its applications	Lecture, Activity	1608.1 1608.2	Home assignments Mid Term 1 End Term
14	Components of electric drives, Factors affecting choice of drives	Introduction of electric drives and its components	Lecture	1608.3 1608.5	Class Quiz Mid Term II End Term
15-17	Fundamental torque equation, Speed torque convention, Multi-quadrant operation of electric drives	Understand the dynamics of electrical drives	Lecture	1608.3	Class Quiz Mid Term II End Term
18-20	Load torque components, Nature of load torque, Classification of load torque	Understand the nature of load in electric drives	Lecture	1608.3	Class Quiz Mid Term II End Term
21-23	Equivalent moment of inertia, Steady state stability, Load equalization	Analysis of stability and equivalent moment of inertia	Lecture	1608.3	Class Quiz End Term
24-25	Motor power rating , Motor duty cycle	Analysis of power rating and Motor duty cycle	Lecture	1608.3 1608.5	End Term Mid Term II
26	Electric braking methods	Interpret the concept of electric braking	Lecture	1608.3	End Term Class Quiz Mid Term II

27-31	DC motor :construction , principle, types of DC motors, Speed torque characteristics of DC Motors, Starting and speed control method of DC motor	Basics of DC motor and speed control using power modulators	Lecture, Activity	1608.4 1608.2	Home Assignment End Term
32	AC motors : introduction of induction motor	Understand the concept of induction motor	Lecture, Activity	1608.4	Class Quiz
33-36	Synchronous motor (SM): construction, Principles, Types of synchronous motor, Starting method of SM, Speed control of SM	To gain concept of synchronous motor and its speed control using power converters	Lecture	1608.4	Class Quiz End Term
37-40	Special Motors: Stepper motor, BLDC motor, PM synchronous motor, Synchronous reluctance motor	Understand the working of special motors and its applications	Lecture, Activity	1608.6	Home Assignment End Term
41-42	Universal motors, LIM, LSM	Basics of Linear motors	Lecture	1608.6	Home Assignment End Term

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

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
MC 1608.1	Describe the construction and working operation of power electronic devices such as SCR, IGBT etc.	3	3	2	2	1	1	1						2	1	2
MC 1608.2	Analysis and working operation of various types of converters such as dc-dc, ac-ac, ac-dc, dc-ac.	3	3	3	3	2	1	1	1					1	2	3
MC 1608.3	Ability to understand the components of electrical drives and dynamics of electrical drives.	2	3	2	2	1	1	1						2	2	2
MC 1608.4	Develop design knowledge on how to design the speed control loops for DC Motor and AC motor.	2	2	3	2	1	2	1	1					3	3	2
MC 1608.5	Ability to develop about selection criteria of motor power ratings.	2	3	2	1		1							1	2	1

MC 1608.6	To learn about working and applications of special motors.	2	1	1	1		1	1	1					1	1	1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Electrical Drives and Machines Lab| MC 1631 | 1 Credits | 0 0 2 1

Session: Jan 18 – May 18 | Faculty: Ashok Kumar Kumawat | Class: B. Tech VI Sem

LLL. Introduction: This course is offered by Dept. of Mechatronics Engineering as a lab, targeting students who wish to pursue research& development in industries or higher studies in field of Mechatronics Engineering, including electrical drive control and power electronics. Offers hands-on experience on power converters and drive control.

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

[1331.25]. Experiment and interpretation of load test on single phase and three phase induction motor.
[1331.26]. Hands-on analysis of load test and speed control on DC motor.
[1331.27]. Implementation of various type of converters such as AC to DC, AC to AC etc.
[1331.28]. Implementation of speed control of electrical drives using microcontroller.

NNN. 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]. Apply the knowledge of basic sciences, analytical skills, and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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 any time 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	

OOO. Syllabus

Speed-torque characteristics, starting, speed control of AC Motors: Asynchronous motors: Induction Motors; and Synchronous Motors Electric Drives: Components of electric drives, Determination of motor power rating, Power Modulators: Use of power semiconductor switches: power diodes, SCR, power transistor, IGBT, MOSFETs; Power converters: ac to ac, ac to dc, dc to ac, dc to dc, Special Machines: Methods of applications of Stepper Motors, Brushless DC Motors.

PPP. Reference Books

R1. G. K. Dubey, Fundamentals of Electric Drives, Narosa publications, 2nd edition, 2001

R2. I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw Hill, New Delhi, 4th edition, 2010

R3. J. D. Edwards, Electrical Machines and Drives, Macmillan publications, UK, 3rd edition,1991.

QQQ. Lecture Plan:

Lab No	**Name of the Experiment**	**Experiment Outcome**	**Type of Expt.**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Study and perform the characteristic of SCR	Understanding about SCR working	Hands-on	NA	Observational Data, Viva-Voce
2	Perform the experiment of single-phase AC voltage controller	Effect of control signal on output waveform	Hands-on	1631.3	Observational Data, Viva-Voce
3	Perform the experiment of single-phase semi-controlled AC voltage controller	Effect of control signal on output waveform	Hands-on	1631.3	Observational Data, Viva-Voce
4	Perform the experiment of Single-Phase Half Wave Controlled Rectifier	Effect of control signal on output waveform	Hands-on	1631.3	Observational Data, Viva-Voce
5	Perform the experiment of Single-Phase Full Wave Fully Controlled Bridge Rectifier	Effect of control signal on output waveform	Hands-on	1631.3	Observational Data, Viva-Voce
6	Single phase full wave symmetrical half-controlled rectifier	Effect of control signal on output waveform	Hands-on	1631.3	Observational Data, Viva-Voce
7	Single phase full wave half-controlled asymmetrical rectifier	Effect of control signal on output waveform	Hands-on	1631.3	Observational Data, Viva-Voce
8	Speed control of AC drives	Speed control implementation	Hands-on	1631.1	Observational Data, Viva-Voce
9	Speed control of DC drives using microcontroller	Speed control implementation	Hands-on	1631.4	Observational Data, Viva-Voce
10	Study and perform the experiment of Speed Control of D.C. Shunt Motor	Effect of load on drive characteristics	Hands-on	1631.2	Observational Data, Viva-Voce
11	Perform the experiment of Load Test on single phase Induction Motor	Effect of load on drive characteristics	Hands-on	1631.1	Observational Data, Viva-Voce
12	Perform the experiment of Load Test on 3 phase Squirrel Cage Induction Motor	Effect of load on drive characteristics	Hands-on	1631.1	Observational Data, Viva-Voce
13	Study and perform the experiment of Torque-Slip Characteristics of 3 phase Slip Ring Induction Motor	Effect of load on drive characteristics	Hands-on	1631.1	Observational Data, Viva-Voce
14	Perform the experiment of Load Test on D.C. Shunt Motor	Effect of load on drive characteristics	Hands-on	1631.2	Observational Data, Viva-Voce

RRR. 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
MC 163 1.1	Experiment and interpretation of load test on single phase and three phase induction motor.				1										2	
MC 163 1.2	Hands-on analysis of load test and speed control on DC motor.				1										2	
MC 163 1.3	Implementation of various type of converters such as AC to DC, AC to AC etc.			1										1	2	
MC 163 1.4	Implementation of speed control of electrical drives using microcontroller					1								1	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Lab Course Hand-out

Programmable and Logic Control Lab| MC 1632 | 1 Credits | 0 0 2 1

Session: Jan 18 – May 18 | Faculty: Mr. Anil Sharma | Class: B. Tech VI Sem

Introduction: This course is offered by Dept. of Mechatronics Engineering as a lab, targeting students who wish to pursue research& development in industries or higher studies in field of Automation Engineering, including Embedded systems, Robotics, and other advanced systems. Offers hands-on experience on varied Programmable Logic Control testing boards.

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

[1632.1] Understand different applications of PLC in industrial automation

[1632.2] Implement interfacing of different switches, sensors and actuators with PLC
[1632.3] Design and Implement PLC program to control different industrial processes such as traffic light, lift control and bottle filling plant.
[1632.4] Apply the knowledge for installation and troubleshooting in automation.

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 problemsreaching 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 designsystem components or processes that meet the specified needs with appropriate consideration for the public healthand safety, and the cultural, societal, and environmental considerations

[PO.4]. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information toprovide 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 insocietal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

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

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

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

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

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

[PSO.1]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

A. 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	

Syllabus

Implementation of Basic Logic Gates – AND, OR, EXOR, NOT, Latching with ON and OFF priorities, SR and JK Flip Flops. Timer Operations – ON delay, OFF delay retentive and nonretentive timers, all possible combination like pulse timer, latching on delay etc. Counter operations – up counter, down counter, up-down counters, High speed counters, Developing programs for Arithmetic operations, Logical Operations, Comparison operations, Analog PLC operations – Accessing Analog inputs, Process and control analog outputs, Conveyor control Systems, Stepper Motor Control, Traffic light Control, Lift Control, Mini project, Bottling Plant.

Text Books:

1. F. D. Petruzella, Programmable Logic Controllers, McGraw- Hills Publications, 4 th edition, 2010.

II. Siemens, PLC Handbook.

III. W. I. Fletcher, An Engineering Approach to Digital Design, Prentice Hall of India Publishers, New Delhi, 1 st edition, 1999.

IV. C. H. Roth, Fundamentals of Logic Design, Jaico Publishing house, 4 th Edition, 1999. 4. Reis & Reis, Programmable Logic Controllers, PHI Learning Publications, 5 th edition, 2002.

Lecture Plan:

Lab No	**Name of the Experiment**	**Experiment Outcome**	**Type of Expt**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Study of Logic Gates and implementation using PLC ladder diagram.	To acquaint and clear teachers expectations and understand student expectations	Live Demo	NA	NA
2	Implementation of Latching circuit and study of its application.	To acquaint with Latching circuit programming	HandsOn	1632.1 1632.2	Observational Data, Viva-Voce
3	Implementation of Switching of Light circuit using PLC logic.	To acquaint with Switching of Light circuit using PLC logic.	HandsOn	1632.3	Observational Data, Viva-Voce
4	Implementation of Door Bell.	To acquaint with l Door Bell.	HandsOn	1632.2 1632.4	Observational Data, Viva-Voce
5	To perform Stepper Motor Control using PLC ladder programming	To acquaint Stepper Motor Control using PLC ladder programming	HandsOn	1632.1	Observational Data, Viva-Voce
6	To perform Stepper Motor Control using PLC ladder programming	To acquaint with Stepper Motor Control using PLC ladder programming	HandsOn	1632.2	Observational Data, Viva-Voce
7	Implementation of Process control using PLC ladder diagram.	To acquaint with Process control using PLC ladder diagram.	HandsOn	1632.5	Observational Data, Viva-Voce
8	To perform Traffic Light Control using PLC ladder diagram.	To acquaint with Traffic Light Control using PLC ladder diagram.	HandsOn	1632.2	Observational Data, Viva-Voce
9	To study and implement Bottle filling Plant using PLC ladder diagram.	To acquaint with basic Bottle filling Plant using PLC ladder diagram.	HandsOn	1632.3	Observational Data, Viva-Voce
10	To study and implementation of Conveyor Control System.	To acquaint implementation of Conveyor Control System.	HandsOn	1632.2	Observational Data, Viva-Voce
11	Study of Industrial Process and implementation using PLC ladder diagram.	To acquaint with Industrial Process and implementation using PLC ladder diagram.	HandsOn	1632.5	Observational Data, Viva-Voce

12	Drilling Tool	To understand about Drilling Tool	HandsOn	1632.3	Observational Data, Viva-Voce
13	Seven segment display using PLC ladder program.	To understand about Seven segment display using PLC ladder program.	HandsOn	1632.1 1632.5	Observational Data, Viva-Voce
14	Seven segment display using PLC ladder program.	To understand about Seven segment display using PLC ladder program.	HandsOn	1632.3	Observational Data, Viva-Voce
15	Implementation of Lift Control logic using PLC ladder diagram.	To understand of Lift Control logic using PLC ladder diagram.	HandsOn	1632.2	Observational Data, Viva-Voce
16	Implementation of Density based traffic light system.	To understand about Density based traffic light system.	HandsOn	1632.2	Observational Data, Viva-Voce

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
MC1632.1	Understand different applications of PLC in industrial automation	3	1	1	1	1			1					1		
MC1632.2	Implement interfacing of different switches, sensors and actuators with PLC		2	1		3								1	2	
MC1632.3	Design and Implement PLC program to control different industrial processes such as traffic light, lift control and bottle filling plant.		2	1	2									2		
MC1632.4	Apply the knowledge for installation and troubleshooting in automation.		3	2	1	1								2	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile, Mechanical and Mechatronics

Department of Mechatronics Engineering

Lab Course Hand-out

Pneumatics & Hydraulics Lab| MC1633 | 1 Credits | 0 0 2 1

Session: 2017-2018 | B.Tech. VI Semester

A. **Introduction** Hydraulic and pneumatic systems are both widely used in stationary (industrial) and off-highway (mobile) equipment. Hydraulic systems are widely used when heavy force or torque is involved, such as lifting loads weighing several tons, crushing or pressing strong materials like rock and solid metal, and digging, lifting, and moving large amounts of earth. And although pneumatics is capable of transmitting high force and torque, it is more widely used for fast-moving, repetitive applications, such as pick-and-place operations, gripping, and repetitive gripping or stamping. In both cases, electronic controls and sensors have been implemented into fluid power systems for the last few decades. These electronics make hydraulic and pneumatic systems faster, more precise and efficient, more reliable, and allow them to be tied into statistical process control and other factory and mobile equipment control networks.

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

[MC1633.1] Specifying Pneumatics valves and their usage criteria used in automation

[MC1633.2] Apply knowledge using the pneumatic circuits in different constraints to operate actuators in various scenarios.

[MC1633.3] Understand the advance circuit concepts of pneumatics and hydraulics to solve industrial problems and enhance employability skills.

[MC1633.4] Analyze the information required to make decisions about usage of valves in various manufacturing environments and industries thus enhancing entrepreneurial skills.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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

Basic Pneumatics: Operation of a single acting cylinder, double acting cylinder by using pneumatic components, Electro Pneumatics: Operation of a Single Acting and Double Acting cylinder Operation of a Single Acting and Double Acting cylinder electro-pneumatically, Operation of a single acting cylinder- controlled from different positions using shuttle (OR) valve and Dual pressure (AND) Valve, Operation of a double acting cylinder using quick exhaust valve and time delay valve, Controlling the speed of double acting cylinder using METERING IN valve and METERING OUT valve, Apply AND/ OR Logic using two manual controls for forward stroke of a double acting cylinder and using relay for actuation, Single cycle automation of multiple cylinders in sequence. Use of hydraulics for actuators.

Text Books:

1. D. Waller, H. Werener and T. Ocker, Electropneumatics workbook Advanced Level, Festo Didactic GMBH & Co, Germany, 2002.

Reference Books:

1. Waller D. and Werner H., Pneumatics Workbook Basic Level, Festo Didactic GMBH & Co, Germany, 1993.
2. Rouff, D. Waller and H. Werener, Electropneumatics Workbook Basic Level, Festo Didactic GMBH & Co, Germany, 1993.

SSS. Lecture Plan:

Lab No	**Name of the Experiment**	**Experiment Outcome**	**Type of Expt**	**Corresponding CO**	**Mode of Assessing the Outcome**
1.	Demonstration	To acquaint and clear teachers expectations and understand student expectations	Live Demo	NA	NA
2	Experiment 1: Study and operation of different valves used in pneumatics and operation of a single acting cylinder, double acting cylinder by using pneumatic components.	To acquaint the students with basics of Pneumatics articles and equipment with the usage of Actuators	Live Demo/Hands ON	1633.1 1633.2	NA
3	Experiment 2: Verify the usage of NO and NC 3/2 push button valve on S/A and D/A cylinder..	To acquaint with usage of NO and NC valves /circuits output	Hands On	1633.2 1633.3	Verification/Implementation of circuit, Viva-Voce
4	Experiment 3: Verification of electro pneumatic circuit for the operation of a S/A and D/A cylinder.	To acquaint with electro pneumatic concepts	Hands On	1633.2 1633.3	Verification/Implementation of circuit, Viva-Voce
5	Experiment 4: Generation of logic circuits by using shuttle and dual pressure valve for operation of D/A cylinder	To acquaint with OR and AND logic circuits	Hands On	1633.2 1633.3	Verification/Implementation of circuit, Viva-Voce
6	Experiment 5: Operation of a double acting cylinder using quick exhaust valve and time delay valve.	To acquaint with the usage of valves for quick return and delayed operation	Hands On	1633.2 1633.3	Verification/Implementation of circuit, Viva-Voce
7	Experiment 6: Controlling the speed of double acting cylinder using METERING IN and METERING OUT circuit.	To acquaint with the circuits used for speed control of actuators	Hands On	1633.2 1633.3	Verification/Implementation of circuit, Viva-Voce
8	Experiment 7: Use of relay for generating logic(OR/AND) circuits with manual control.	To acquaint with electro pneumatic circuit for logic gates	Hands On	1633.2 1633.3	Verification/Implementation of circuit, Viva-Voce
9	Experiment 8: Single cycle automation of multiple cylinders in sequence. (Sequence of Motion: A+B+A-B-).	To acquaint with circuits required for automation	Hands On	1633.3 1633.4	Verification/Implementation of circuit, Viva-Voce

10	Experiment 9: Application of cascading method for single cycle automation of multiple cylinders (Sequence of Motion: A+B+B-A-).	To acquaint with techniques for designing of pneumatic circuits	Hands On	1633.3 1633.4	Verification/Implementation of circuit, Viva-Voce
11	Experiment 10: Application of cascading method for multi cycle automation of multiple cylinders (Sequence of Motion: A+B+B-A-).	To acquaint with techniques for designing of pneumatic circuits	Hands On	1633.3 1633.4	Verification/Implementation of circuit, Viva-Voce
12	Experiment 11: Use of hydraulics for operation of D/A cylinder.	To acquaint with basic motion of hydraulics	Hands On	1633.1 1633.2	Verification/Implementation of circuit, Viva-Voce
13	Experiment 12: Demonstrating the use of hydraulic motor.	To understand the use of hydraulic motor	Hands On	1633.1 1633.2	Verification/Implementation of circuit, Viva-Voce
14	Experiment 13: Use of 4/3 DC valve for pressure less circulation with centre position of valve.	To understand about usage of 4/3 tandem valves in hydraulics	Hands On	1633.3 1633.4	Verification/Implementation of circuit, Viva-Voce
15	Experiment 14: Use of 4/3 DC valve for blocking of all ports with direction control valve in the centre position and stopping the piston in different positions.	To understand about 4/3 valves and its usage.	Hands On	1633.3 1633.4	Verification/Implementation of circuit, Viva-Voce

TTT. 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
MC1633.1	Specifying Pneumatics valves and their usage criteria used in automation	3		2		1		3	2	2				2	1	1
MC1633.2	Apply knowledge using the pneumatic circuits in different constraints to operate actuators in various scenarios. .	3		3		1		3	2	2				2	1	
MC1633.3	Understand the advance circuit concepts of pneumatics and hydraulics to solve industrial problems and enhance employability skills.	3		2		1		3	2	2				2	2	
MC1633.4	Analyze the information required to make decisions about usage of valves in various manufacturing environments and industries thus enhancing entrepreneurial skills.	3		2		1		3	2	2				2	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering

Course Hand-out

Embedded System Design| MC 1654 | 3 Credits | 3 0 0 3

Session: Jan 18 – May 18 | Faculty: Kumar Gaurav | Class: Dep. Elective (VI Sem)

A. Introduction: This course is offered by Dept. of Mechatronics Engineering as a department elective, targeting students who wish to pursue research & development in industries or higher studies in field of embedded systems. It gives knowledge about design, implementation and analysis of embedded computer hardware and software. Next, the students will be exposed to the very important issue of designing for less power consumption and introduce them to the techniques that are adopted to this end. Since many of the embedded systems will have real time constraints, basic issues of real time operating systems will be discussed. This will be followed by formal specification models and languages, mapping the specification to hardware and software components along with decisions on design tradeoffs and hardware software partitioning.

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

[1654.1]. To introduce students to the modern embedded systems and show how to understand and progam such systems using a concrete platform built around.

[1654.2]. To provide experience to integrate hardware and software for microcontroller applications systems.

[1654.3]. Discuss the major components that constitute an embedded system.

[1654.4]. Implement small programs to solve well defined problems on an embedded platform.

[1654.5]. To know and understand the usage of Task Scheduling Policies.

[1654.6]. To understand network protocols that can be used for inter device communications.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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.	

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

EMBEDDED SYSTEM DESIGN: Introduction, Classification and major application areas of Embedded System, Embedded System Design: Code design issues in System development process, the typical embedded system, Characteristics and quality attributes of embedded system. Embedded system- Applications and Domain specific, Design cycle in the development phase for an embedded system, designing embedded system with 8 bit microcontrollers, Role of processor selection in Embedded System. Hardware software Co-design and program modeling, fundamental issues, computational models in embedded system design, hardware software trade-offs, Operating system: basics, Real Time Operating System: Types of operating systems, Tasks, Process and Threads. Semaphores and shared Data, Task scheduling, Multiprocessing and multitasking, Operating system Services-Message queues-Timer Function-Events-Memory Management, device drivers, basic design Using RTOS, Networks for Embedded Systems: The I2C Bus, The CAN bus, Ethernet, Introduction to Blue tooth: Specification, IEEE 1149.1 (JTAG)

Testability: Boundary Scan Architecture, Control Systems, Open loop and closed loop control systems; Cruise controller, General control systems and PID controller, software coding of PID controller, Practical issues related to computer based control.

F. Text Books

T1. R. Kamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw Hill, 2nd edition, 2008

T2. K. J. Ayala, Dhananjay, V. Gadre, The 8051 Microcontroller and Embedded systems, Cengage Learning Publishers, 2010.

G. Reference Books

R1. K. V. Shibu, Introduction to Embedded systems, Tata McGraw Hill, 2009

R2. S. Siewert, Real time embedded systems and component, Cengage Learning, 2007

R3. F. Vahid, T. Givargis, Embedded Systems Indian Edition, Wiley Publications, 2002

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	Embedded systems – Introduction	Recall working of Microprocessors and Microcontrollers	Lecture	1654.1	In Class Quiz (Not Accounted)
3	Classification of embedded systems	Categorise different embedded system	Lecture	1654.1	In Class Quiz End Term
4	Major application areas of embedded system	Different areas where embedded systems are prominent	Self Study	1654.1	Home Assignment End Term
5,6	Design metrics and Code design issues in system development process	Design of Embedded system	Lecture	1654.2	In Class Quiz End Term
7,8	Typical Embedded system	Embedded system with example and components	Lecture	1654.2	Class Quiz Mid Term I End Term
9,10	Characteristics of Embedded system	Overview of embedded system in context to different processor/controllers.	Lecture	1654.2	Class Quiz Mid Term 1 End term
11	Quality attributes of embedded system and Embedded system applications	Overview of quality attributes	Lecture	1654.2	Home Assignment Class Quiz Mid Term 1 End Term
12	ES domain specific	Domain specific application discussion	Lecture	1654.2	Class Quiz Mid Term 1 End Term
13	Design cycle in the development phase for an embedded system	Importance of design and development of ES	Lecture	1654.2	Class Quiz Mid Term I End Term
14	Designing ES crocontrollers with 8 bit mi	Role of Microcontrollers	Lecture	1654.2	Class Quiz End Term
15,16	Designing ES bit with 8 microcontrollers (Introduction to AVR)	Analyse Role of Microcontrollers	Lecture	1654.4	Class Quiz Mid Term II End Term
17,18,19	Designing ES bit with 32 microcontrollers (Introduction to ARM)	Introduction to ARM processor	Lecture, Activity	1654.4	Class Quiz Mid Term II End Term
20	Role of processor selection in ES	Processor selection	Lecture, Activity	1654.4	Class Quiz Mid Term II
					End Term

21	Hardware and Software Co-Design	Hardware design issues	Lecture	1654.4	Class Quiz Mid Term II End Term
22	Introduction to Program Modeling, fundamental issues	Discussion	Lecture	1654.4	Class Quiz End Term
23	Computational models in ES, Hardware and Software trade-offs	Discussion regarding computational models	Lecture	1654.4	Class Quiz End Term
24	Operating System Basics	Discussion about OS basics	Lecture	1654.4	Class Quiz End Term
25	Introduction to RTOS(Real time operating system)	Extended discussion	Lecture	1654.4	Class Quiz End Term
26	Real time Operation system basics	Extended discussion	Lecture	1654.5	Class Quiz End Term
27,28	Types of operating systems	Classification of Operating systems	Lecture	1654.5	Class Quiz End term
29,30,31	Tasks and their importance, Process and Threads	Importance of process	Lecture	1654.5	Class Quiz
32	Semaphores in multitasking, Shared data	Communication between processes and tasks	Lecture	1654.5	Class Quiz Mid Term II End Term
33,34,35	Task Scheduling, Multiprocessing & Multitasking	Concept of priority queues	Lecture	1654.5 1654.3	Class Quiz Mid Term II End Term
36,37	Message Queues	Extended discussion	Lecture	1654.5 1654.3	Class Quiz Mid Term II End Term
38,39,40	Memory Management, Device Drivers	Discussion about memories in ES	Lecture	1654.5 1654.3	Class Quiz End Term

41, 42	Basic Design using RTOS	Description about the topic	Lecture	1654.5 1654.3	Class Quiz End Term
43	Network of ES: I2C Bus, SPI	Network of ES	Lecture	1654.1	Class Quiz End Term
44	CAN bus, Ethernet	Detail discussion	Lecture	1654.1	Class Quiz End Term
45	Bluetooth	Specifications	Lecture	1654.1	Class Quiz End Term
46	Specification IEEE 1149.1 (JTAG)	Specifications	Lecture	1654.1	Class Quiz End Term
47,48	Testability: Boundary Scan Architecture,	Analyse the concept of testability	Lecture	1654.5	Class Quiz End Term
49,50	Control system, open loop and closed loop control system	Overview	Lecture	1654.5	Class Quiz End Term
51	Ex: cruise controller, general control system and PID controller	overview	Lecture, Activity, self study	1654.6	Class Quiz End Term
52	Conclusion and Course Summarization	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
MC 1654.1	Describe the importance of embedded system	2	2							1				1	1	

MC 1654.2	Interpret and illustrate the use of different microcontrollers based platforms for better learning		3	1	1										2	2
MC 1654.3	Important peripherals of embedded system and memory organization.					3		1	1	1	1		3	1	1	
MC 1654.4	Overview of programming techniques in assembly language		1	2	2	1		1								2
MC 1654.5	Learn to develop small programs for task scheduling and processes.	1	1	2	1			1	1					1	1	1
MC 1654.6	To study and implement different network protocols for embedded systems.	1	1	1	1	1	1				3	1	1		1	1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Modern Control System | MC1752 | 3 Credits | 3 0 0 3

Session: Jan 18 – May 18 | Faculty: Princy Randhawa | Class: Program Elective

A. INTRODUCTION: This course is offered by Dept. of Mechatronics Engineering as a Program Elective. This course covers the design and analysis of sampled data systems and provides a theoretical basis for applying the methods of state space and multivariable systems design. It also develops an understanding of how interactions between and within loops can be handled by design.

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

[MC1752.1] Outline the basics of linear and nonlinear systems background with emphasis on state space techniques and writing the state space equation for electrical, mechanical and analogous systems.

[MC1752.2] Interpret how the time response of linear time-invariant systems are linked to state space parameter and the connection between transfer function and state-space models. Understand the stability concept and its link to the transfer function pole locations and state space parameters.

[MC1752.3] Describe about the extending state-space analysis and gains an appreciation of recent advances in control Engineering such as pole assignment, observers design, introduction to optimal, adaptive and Identification techniques.

[MC1752.4] Analyse and learn why standard methods of analysis and design in linear systems are not applicable in Non-linear system. Methods suitable for nonlinear systems are introduced and their applications are Explored.

[MC1752.5] Recall the fundamental concepts of Digital Control Systems and to understand the design of Digital Controllers.

[MC1752.6] Prepare the students for the use MATLAB and SIMULINK to analyse and design control systems and Digital Controllers.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, Power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	15
	Sessional Exam II (Closed Book)	15
	In class Quizzes and Assignment on MATLAB for designing any system	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. 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 classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS:

Sampled Data Control Systems, Signal Reconstruction, sampling process, ZOH, mapping between s and z planes – pulse transfer functions – step response – stability analysis – Jury's stability test, Bilinear Transformation, Bode plot, Root Locus models for Discrete Time system, Diagonalization, State Transition Matrix, Solution of equation for discrete time system by recursion and z-transform method, Concepts of Controllability and Observability, pole placement by state feedback-Ackerman's Formula- State Observers, Properties of non-linear systems - common physical non-linearity - dead zone, relay, and saturation nonlinearities - phase plane method-singular points phase trajectories, Isocline Method , Liapunov's stability criterion.

F. Text Books:

Ogata, K., Modern Control Engineering, Prentice-Hall, [2002]

Hsu, J. C. & A. U. Meyer, Modern Control Principles and Applications, McGraw-Hill, [1968] **G.**

Secondary References:

Gopal, M., Modern Control System Theory, John Wiley Eastern Ltd. New Delhi, [1984]

Friedland, B., Control System Design, McGraw-Hill, [1986]

M.Gopal , "Digital Control and State Variable Methods" , Tata McGraw Hill New Delhi , 2005

Kuo, B.C., "Digital Control Systems", Oxford University press, 1992.

Ogata, K., State Space Analysis of Control Systems, Prentice-Hall, [1967]

Kuo, B. C., Automatic Control Systems, Prentice-Hall, [1987]

Slotine, J. E. & Weiping Li, Applied Nonlinear Control, Prentice-Hall, [1991]

Gibson, J. E., Nonlinear Automatic Control, McGraw-Hill, [1963] **Software:**

MATLAB: Control and Simulink Tool Boxes, Math Works Inc.

H. Lecture Plan:

Lec. No	**Topics**	**Session Objective**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Introduction to State Space Representation, Difference between classical and Modern Control Theory, Advantage of State Space Analysis	To understand the importance of state space analysis	Lecture	CO.1 & CO.2	In Class Quiz (Not Accounted)
3,4	Definitions- State, State Variable, State vector, State space, State Trajectory, State Space Model of Linear System, State Space Representation of a System, State Diagram	Few definitions for understanding state space analysis	Lecture	CO.1 & CO.2	In Class Quiz
5,6	Introduction to Eigen values, Eigen vectors and its diagonalization	Physical meaning of the terms and its usage	Lecture	CO.2	Home Assignment
7.-10	Computation of state transition matrix and its Properties, Numerical Practice	To practice numerical on state space analysis for finding eigen value,eigen,vector,STM mathematically	Lecture, Flipped Classroom	CO.3	In Class Quiz
11	Concepts of Controllability and Observability – linear time invariant systems	Study of Observer design and to check the stability of a system		CO.3	Home Assignment Class Quiz
12-14	Pole placement by state feedback, Introduction to State observers	Study of Observer design and to check the stability of a system	Lecture	CO.3	Class Quiz
15,16	Ackerman's Formula-Observers – Full order and reduced order, Numerical Practice	Analyse the system and check for stability and design full and state observer	Lecture	CO.3	Class Quiz
17	Introduction to Control System using MATLAB	Acquaint students with the brief overview of control system toolbox	Software Learning	CO.6	Class Quiz
18-19	How to write State Space Equation ,To Check controllability, Observability using MATLAB	To check for stability conditions by and analysing in MATLAB	Software Learning	CO.6	Class Quiz, Case Study
20	Introduction to Digital Control System, Sampling, Quantisation	What is digital control system and its	Flipped Classroom	CO.5	Class Quiz

		importance in control system			
21	Sampled data Control System, Block Diagram Analysis of Sampled Data Control System	Study of ADC, sampler and Hold circuits	Lecture	CO.5	Class Quiz
22-24	Signal Reconstruction , Introduction to Zero Order Hold Circuit	Use of Zero order hold circuit and its transfer function	Lecture	CO.5	Class Quiz
25	Introduction to Z transform, Z and S domain Relationship	Acquaint about z transform and its properties and formulas	Lecture	CO.5	Class Quiz
26	Difference Equation, Z-transfer Function	How to use z transform in difference equation	Lecture	CO.5	Class Quiz
27-30	Stability Analysis by Bilinear Transformation Method, Jury Stability Test	Stability analysis for digital control system	Lecture	CO.5	Class Quiz
31-32	Introduction to Non Linear Control and its Properties, Common Physical Non LinearityDead zone, Saturation, Relay, Introduction to phase plane method	Non linearity's present in Nonlinear system	Lecture	CO.4	Home Assignment
33-35	Lyaponuv Stability Criteria, Lyapunov stability theorem, Singular Point, Phase trajectories, Numerical Practice	Stability Criteria for Non Linear System	Lecture	CO.4	Class Quiz
36	Introduction to Robust Control, Optimal Control, Adaptive control	Introduction to Advanced Control system	Lecture	CO.3	Class Quiz
37	Revision	NA	NA, Flipped Classroom	NA	NA

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

CO	STATEMENT	CORRELTION 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

MC 1752.1	Outline the basics of linear and nonlinear systems background with emphasis on state space technique and writing the state space equation for electrical, mechanical and analogous systems.	3	2			2								3	2	
MC 1752.2	Interpret how the time response of linear time-invariant systems are linked to state space parameter and the connection between transfer function and state-space models. Understand the stability concept and its link to the transfer function pole locations and state space parameters.	1			2	3								2		
MC 1752.3	Describe about the extending state-space analysis and gains an appreciation of recent advances in control engineering such as pole assignment, observers design, introduction to optimal, adaptive and Identification techniques.	2		3	3	2								2	3	
MC 1752.4	Analyse and learn why standard methods of analysis and design in linear systems are not applicable in Non-linear system. Methods suitable for nonlinear systems are introduced and their applications are explored.	3	2	2		3								2	1	
MC 1752.5	Recall the fundamental concepts of Digital Control Systems and to	3		1		2								1	2	
	understand the design of Digital Controllers.															

MC 1752.6	Prepare the students for the use MATLAB and SIMULINK to analyse and design control systems and Digital Controllers.	2		1	2	3								3	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering

Course Hand-out

Production Technology | MC 1656 | 3 Credits | 3 0 0 3

Session: Jan-18 – June 18 | Faculty: Dr. Manish Rawat| Class: Programme Elective (VI Sem.)

A. Introduction: This course is offered by Dept. of Mechatronics Engineering as programme elective. In this course the students study the fundamentals and advanced techniques related to advance manufacturing processes. In addition to the applied aspects of manufacturing processes, a sound analytical basis for some of the processes will be taught. This course builds a foundation of capability for the solution, analysis and synthesis of un-conventional machining and gear manufacturing problems.

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

[1656.1] To understand the principle, mechanism of metal removal of various unconventional machining processes.
[1656.2] Assimilate the Gear manufacturing & finishing processes.
[1656.3] Understand the shaping procedures and compression principles of powders and plastic materials.
[1656.4] Recognize the different types of press operations and their contributions in the product development.
[1656.5] Select appropriate cutting tools, work holding devices and cutting parameters for the given work piece.

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] Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

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.	

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:

Non-conventional Machining: EDM, IBM, ECM, ECG, CM, AJM, Wire cut EDM, USM, LBM, **Gear and Thread Manufacturing:** Different types of Threads manufacturing methods, and tools involved, Different gear forming and generating methods. Gears finishing processes. **Powder Metallurgy**: Production of metal powders, compaction and sintering. **Polymers and Composites:** Introduction to polymers and composites; plastic processing – injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites. **Press Tool:** Classification of presses, Classification of dies, cutting actions in dies, clearance, Methods of reducing cutting forces, Minimum Diameter of Piercing Centre of Pressure, Blanking, Piercing, Drawing, Bending and Progressive Die design, scrap reduction, strip layout. **Jigs and Fixtures:** Differences between Jigs and Fixtures, Design principles, 3-2-1 location principle, Types of locators, Concept of work piece control, Geometric control, Dimensional control and Mechanical control, Jigs and fixtures for various machining operations.

F. Text Books:

1. S. Kalpakjian, and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Education, 6th Edition, 2009.
2. Ghosh, and Asok Kumar Malik, Manufacturing Science, Affiliated East West Press Pvt. Ltd., 2nd Edition, 2010.
3. P.C. Sharma, A text book of Production Technology, S. Chand and Company, 4th Edition, 2006.
4. R.K. Jain, Production Technology: Manufacturing Processes, Technology and Automation, Khanna Publishers, 17th Edition, 2011.
5. P. N. Rao, Manufacturing Technology Volume-1, Tata McGraw-Hill Education, 4th Edition, 2013.

G. Reference Books :

1. M. C. Shaw, Metal Cutting principles, Oxford University press, 2nd edition, 2004.
2. Boothroyd, Fundamentals of machining and machine tools, CRC publication, 2005.
3. HMT Bangalore, Production Technology H.M.T., Tata McGraw Hill Pub, 2001.
4. Donaldson, Tool Design, Tata McGraw Hill Pub, 4th edition, 2012.
5. Trent, Metal cutting Principles, Tata McGraw Hill Pub, 4th edition, 2000.

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		Lecture	NA	NA
2	Introduction of Un-conventional machining and its classification	To understand the principle, mechanism of metal removal of various unconventional machining processes	Activity (Think Pair Share)	1656.1	In Class Quiz (Not Accounted)
3,4	Introduction and working of EDM, Wire Cut EDM and ECM	To understand the principle, mechanism of metal removal of various unconventional machining processes	Lecture	1656.1	In Class Quiz End Term
5,6	Introduction and working of AJM and ECG	To understand the principle, mechanism of metal removal of various unconventional machining processes	Lecture	1656.1	Home Assignment End Term
7.8	Introduction and working of EBM and LBM, USM	To understand the principle, mechanism of metal removal of various unconventional machining processes	Lecture	1656.1	In Class Quiz End Term
9	Classification of Gear and Thread Manufacturing	Assimilate the Gear manufacturing & finishing processes	Activity (Think Pair Share)	1656.2	Class Quiz Mid Term I End Term
10	Different types of Threads manufacturing methods tools involved,	Assimilate the Gear manufacturing & finishing processes	Activity (Jigsaw)	1656.2	Class Quiz Mid Term 1 End term
11	Different types of Gear manufacturing methods tools involved,	Assimilate the Gear manufacturing & finishing processes	Flipped Class	1656.2	Home Assignment Class Quiz Mid Term 1 End Term
12, 13	Different gear forming and generating methods	Assimilate the Gear manufacturing & finishing processes	Activity (Think Pair Share)	1656.2	Class Quiz Mid Term 1 End Term
14	Different gears finishing processes	Assimilate the Gear manufacturing & finishing processes	Lecture	1656.2	Class Quiz Mid Term I End Term
15,16	Introduction of powder metallurgy process and its need	Understand the shaping procedures and compression principles of powders and plastic materials	Jigsaw	1656.3	Class Quiz Mid Term II End Term
17	Production of different metal powders	Understand the shaping procedures and	Lecture, Activity	1656.3	Class Quiz Mid Term II

		compression principles of powders and plastic materials			End Term
18	Different Process involved in the powder metallurgy process	Understand the shaping procedures and compression principles of powders and plastic materials	Lecture, Activity	1656.3	Class Quiz Mid Term II End Term
19	Introduction to polymers and composites	Understand the shaping procedures and compression principles of powders and plastic materials	Lecture	1656.3	Class Quiz Mid Term II End Term
20	Plastic processing – injection, compression and blow molding, extrusion, calendaring and thermoforming	Understand the shaping procedures and compression principles of powders and plastic materials	Lecture	1656.3	Class Quiz End Term
21	Plastic processing –extrusion, calendaring and thermoforming	Understand the shaping procedures and compression principles of powders and plastic materials	Lecture	1656.3	Class Quiz End Term
22	Molding of composites	Understand the shaping procedures and compression principles of powders and plastic materials	Lecture	1656.3	Class Quiz End Term
23	Classification of presses, Classification of dies, cutting actions in dies, clearance	Recognize the different types of press operations and their contributions in the product development.	Lecture	1656.4	Class Quiz End Term
24	Methods of reducing cutting forces, Minimum Diameter of Piercing Centre of Pressure	Recognize the different types of press operations and their contributions in the product development.	Lecture	1656.4	Class Quiz End Term
25	Different operations of press working	Recognize the different types of press operations and their contributions in the product development.	Lecture	1656.4	Class Quiz End term
26	Bending and Progressive Die design, scrap reduction, strip layout.	Recognize the different types of press operations and their contributions in the product development.	Lecture	1656.4	Class Quiz

27	Jigs and Fixtures: Differences between Jigs and Fixtures	Select appropriate cutting tools, work holding devices and cutting parameters for the given work piece	Lecture	1656.5	Class Quiz Mid Term II End Term
28,29	Design principles, 3-2-1 location principle	Select appropriate cutting tools, work holding devices and cutting parameters for the given work piece	Lecture	1656.5	Class Quiz Mid Term II End Term
30,31	Types of locators, Concept of work piece control	Select appropriate cutting tools, work holding devices and cutting parameters for the given work piece	Lecture	1656.5	Class Quiz Mid Term II End Term
32,33	Geometric control, Dimensional control and Mechanical control	Select appropriate cutting tools, work holding devices and cutting parameters for the given work piece	Lecture	1656.5	Class Quiz End Term
34,35	Jigs and fixtures for various machining operations	Select appropriate cutting tools, work holding devices and cutting parameters for the given work piece	Lecture	1656.5	Class Quiz End Term
36, 37	Jigs and fixtures for various machining operations	Select appropriate cutting tools, work holding devices and cutting parameters for the given work piece	Lecture	1656.5	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	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
MC 1656.1	To understand the principle, mechanism of metal removal of various unconventional machining processes	3				2										3
MC 1656.2	Assimilate the Gear manufacturing & finishing processes	3				3						2				2

MC 1656.3	Understand the shaping procedures and compression principles of powders and plastic materials				2							2				2
MC 1656.4	Recognize the different types of press operations and their contributions in the product development.						2		2	3						2
MC 1656.5	Select appropriate cutting tools, work holding devices and cutting parameters for the given work piece	2				3										2

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering

Course Hand-out

Production and Operation Management| MC 1701 | 4 Credits | 4 0 0 4

Session: July 17 – Nov 17 | Faculty: Dr. Manish Rawat | Class: CORE

A. Introduction: Operations Management is the systematic approach and control of the processes that transform inputs (e.g. human resources, facilities, materials, Information systems etc.) into finished goods and services. The operations function consists of the core wealth creation processes of a business and helps an organization to efficiently achieve its mission while constantly increasing productivity and quality. This course focuses on the role of operations management as a strategic element of the total organization. We will cover classic and up-to-date tools and concepts used to support operational managerial decisions.

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

To gain an understanding and appreciation of the principles and applications relevant to the planning, design, and operations of manufacturing/service firms.

[1701.1]	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.
[1701.2]	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.
[1701.3]	To develop skills in solving production and operation management problems.
[1701.4]	To recognize, appreciate, and perform the job of a competent production or operation manager.
[1701.5]	To understand the managerial responsibility for Operations, even when production is outsourced.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, and strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	20
	Sessional Exam II (Close Book)	20
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	10
End Term Exam (Summative)	End Term Exam (Close Book)	50
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

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: Introduction to production and operations management, Types of production activities- continuous, job order and custom work, Production consumption cycle, Functions of production and operations management, Forecasting: Importance and uses of forecasting, Type of forecasts, Exponential smoothing, Linear regression analysis, Logarithmic straight line, Correlation analysis and Seasonality, Forecast control, Product Development and Design: Factors affecting product development and design, Product analysis, Economic analysis, Standardization, Flow Diagrams and Man machine charts, Capacity Planning: Design capacity, System Capacity and System Efficiency, Factors affecting system capacity, Steps in capacity planning, Determination of equipment and manpower requirements, Decision tree analysis for capacity planning, Breakeven analysis in capacity planning, Aggregate Planning: Pure and mixed strategies of aggregate planning, Trial and error approach, Use of transportation algorithm, Job Shop Scheduling: Factors affecting job shop scheduling, Index method, Priority sequencing rules such as FCFS, SPT, EDD and Critical Ratio, Determination of mean flow time, average job lateness and average number of jobs in the system, Inventory management: Introduction, Classification of inventories, Economic order quantity, Inventory control models, Effect of quantity discount, Safety stock, Reorder level, Lead time, ABC Analysis, MRP: Introduction, Product structure tree, MRP inputs & outputs, MRP logic, Line balancing: Meaning and determination of cycle time and theoretical minimum number of workstations, Precedence diagram, Priority rules for allocation of tasks to workstations, Longest work element time rule, Maximum following tasks rule, Location: Factors affecting location, Qualitative methods of location, Quantitative methods of location, Load distance method, Centre of gravity analysis, Plant layout.

Textbooks:

1. E. Jr. Adam Everett and Ronald J Ebert., *Production and Operations Management*, Prentice Hall of India, New Delhi, 2002.
2. Joseph G. Monks, *Operations Management*, Tata McGraw-Hill, New Delhi, 2004.

References:

1. Richard B. Chase, Nicholas J. Aquilano and Jacobs F. Roberts, *Production and Operations management*, Tata McGraw-Hill, New Delhi, 1999.
2. Eilon Samuel, *Elements of Production Planning and Control*, Universal Publishing Corporation, Mumbai, 1991.
3. Lee J. Krajewski and Larry P. Ritzman**,** *Operations Management*, Pearson Education, Singapore, 2005. Gupta Prem Kumar and D. S**.** Hira**,** *Operations Research*, S. Chand & Co. Ltd., New Delhi, 2003

4. . **Lecture Plan:**

Lecture No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1	Introduction and Course Hand-out briefing		Lecture	NA	NA
2	Introduction of production and operations management.	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	In Class Quiz (Not Accounted)
3	**Forecasting**: importance, use and types of forecast technique	To understand the managerial responsibility for Operations, even when production is outsourced..	Lecture	1701.5	In Class Quiz
4	Correlation analysis and seasonality	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	End Term
5	Forecast control	To develop skills in solving production and operation management problems;	Lecture	1701.3	Home Assignment
6	**Product Development and Design**: an introduction	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	End Term
7	Factors affecting product development and design	To understand the managerial	Lecture	1701.5	
		responsibility for Operations, even when production is outsourced.			

8	Product analysis	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	In Class Quiz
9	Economic analysis and Standardization	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	End Term
10	Flow Diagrams and Man machine charts	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Class Quiz
11	**Capacity Planning:** an introduction	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	Mid Term I
12	Design capacity, System Capacity and System Efficiency	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	End Term
13	Factors affecting system capacity	To understand the managerial responsibility for Operations, even	Lecture	1701.5	Class Quiz
		when production is outsourced.			
14	Steps in capacity planning	To recognize, appreciate, and perform the job of a competent production or	Lecture	1701.4	Mid Term 1

		operation manager			
15	Decision analysis for capacity tree planning	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	End term
16	Breakeven analysis in planning capacity	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	Home Assignment
17	**Aggregate Planning:** an introduction	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Class Quiz
18	Pure and mixed strategies of aggregate planning	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	Mid Term 1
19	**MRP:** Introduction and its use		Lecture	1701.1	End Term
20	Product structure tree, MRP inputs & outputs, MRP logic	To recognize, appreciate, and perform the job of a competent	Lecture	1701.4	Class Quiz
		production or operation manager			

21	**Line balancing**: Meaning and determination of cycle time	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Mid Term 1
22	Theoretical minimum number of workstations		Lecture	1701.1	End Term
23	**Job Shop Scheduling**: an introduction and its importance	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	Class Quiz
24	Factors affecting job shop scheduling		Lecture	1701.1	Mid Term I
25	Index method,	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	End Term
26	Priority sequencing rules	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Class Quiz
27	FCFS and numerical		Lecture	1701.1	End Term
28	SPT and numerical examples	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Class Quiz
29	EDD and numerical examples	To recognize, appreciate, and perform the job of	Lecture	1701.4	Mid Term II
		a competent production or operation manager			
30	Average job lateness	To develop skills in solving production and operation	Lecture	1701.3	End Term

		management problems;			
31	Average number of jobs in the system	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz
32	**Inventory management:** Introduction	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	Mid Term II
33	Classification of inventories, Economic order quantity	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	End Term
34	Inventory control models	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz
35	Effect of quantity discount	To develop skills in solving production and operation management problems;	Lecture	1701.3	Mid Term II
36	Quality Control: Meaning of Quality, Quality assurance system,	To develop skills in solving production	Lecture	1701.3	End Term
		and operation management problems;			

37	Inspection and control of quality; Process control charts,	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz
38	Acceptance sampling, Concept of Six Sigma.	To develop skills in solving production and operation management problems;	Lecture	1701.3	Mid Term II
39	Reliability and Maintenance Planning:		Lecture	1701.1	End Term
40	Constant failure rate and Timedependent failure rate models for system components;	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz
41	System reliability determination;	To develop skills in solving production and operation management problems;	Lecture	1701.3	End Term
42	Types of maintenance.	To acquire a working understanding of the roles/functions of production management in the context of business enterprise;	Lecture	1701.2	Class Quiz
43	Queuing Model: Introduction,	To develop skills in solving production and operation management problems;	Lecture	1701.3	End Term

44	Markov Chains and Markov Processes,	To develop skills in solving production	Lecture	1701.3	Class Quiz
		and operation management problems;			
45	Birth-Death Processes,	To develop skills in solving production and operation management problems;	Lecture	1701.3	End Term
46	Simple Queueing Models M/M/-/- Queues.	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz
47	Case Stduy-1		Lecture		
48	Case Stduy-1I		Lecture		

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
MC1761.1	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	3							1					1		3
MC1761.2	To acquire a working understanding of the roles/functions of production management in the context of business enterprise;		2	2								2		1		3
MC1761.3	To develop skills in solving production and operation management problems;				2	2								1		3
MC1761.4	To recognize, appreciate, and perform the job of a competent production or operation manager						2		2	3				1		3
MC1761.5	To understand the managerial responsibility for Operations, even when production is outsourced,			1						1	1			1		3

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering

Course Hand-out

Production and Operation Management| MC 1701 | 4 Credits | 4 0 0 4

Session: July 17 – Nov 17 | Faculty: Dr. Manish Rawat | Class: CORE

D. Introduction: Operations Management is the systematic approach and control of the processes that transform inputs (e.g. human resources, facilities, materials, Information systems etc.) into finished goods and services. The operations function consists of the core wealth creation processes of a business and helps an organization to efficiently achieve its mission while constantly increasing productivity and quality. This course focuses on the role of operations management as a strategic element of the total organization. We will cover classic and up-to-date tools and concepts used to support operational managerial decisions.

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

To gain an understanding and appreciation of the principles and applications relevant to the planning, design, and operations of manufacturing/service firms.

[1701.6]	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.
[1701.7]	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.
[1701.8]	To develop skills in solving production and operation management problems.
[1701.9]	To recognize, appreciate, and perform the job of a competent production or operation manager.
[1701.10]	To understand the managerial responsibility for Operations, even when production is outsourced.

F. 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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, and strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

F. Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	20
	Sessional Exam II (Close Book)	20
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	10
End Term Exam (Summative)	End Term Exam (Close Book)	50
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
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.

G. Syllabus

Introduction: Introduction to production and operations management, Types of production activities- continuous, job order and custom work, Production consumption cycle, Functions of production and operations management, Forecasting: Importance and uses of forecasting, Type of forecasts, Exponential smoothing, Linear regression analysis, Logarithmic straight line, Correlation analysis and Seasonality, Forecast control, Product Development and Design: Factors affecting product development and design, Product analysis, Economic analysis, Standardization, Flow Diagrams and Man machine charts, Capacity Planning: Design capacity, System Capacity and System Efficiency, Factors affecting system capacity, Steps in capacity planning, Determination of equipment and manpower requirements, Decision tree analysis for capacity planning, Breakeven analysis in capacity planning, Aggregate Planning: Pure and mixed strategies of aggregate planning, Trial and error approach, Use of transportation algorithm, Job Shop Scheduling: Factors affecting job shop scheduling, Index method, Priority sequencing rules such as FCFS, SPT, EDD and Critical Ratio, Determination of mean flow time, average job lateness and average number of jobs in the system, Inventory management: Introduction, Classification of inventories, Economic order quantity, Inventory control models, Effect of quantity discount, Safety stock, Reorder level, Lead time, ABC Analysis, MRP: Introduction, Product structure tree, MRP inputs & outputs, MRP logic, Line balancing: Meaning and determination of cycle time and theoretical minimum number of workstations, Precedence diagram, Priority rules for allocation of tasks to workstations, Longest work element time rule, Maximum following tasks rule, Location: Factors affecting location, Qualitative methods of location, Quantitative methods of location, Load distance method, Centre of gravity analysis, Plant layout.

Textbooks:

3. E. Jr. Adam Everett and Ronald J Ebert., *Production and Operations Management*, Prentice Hall of India, New Delhi, 2002.
4. Joseph G. Monks, *Operations Management,* Tata McGraw-Hill, New Delhi, 2004.

References:

5. Richard B. Chase, Nicholas J. Aquilano and Jacobs F. Roberts, *Production and Operations management,* Tata McGraw-Hill, New Delhi, 1999.
6. Eilon Samuel, *Elements of Production Planning and Control,* Universal Publishing Corporation, Mumbai, 1991.
7. Lee J. Krajewski and Larry P. Ritzman**,** *Operations Management,* Pearson Education, Singapore, 2005.
8. Gupta Prem Kumar and D. S**.** Hira**,** *Operations Research,* S. Chand & Co. Ltd., New Delhi, 2003.

F. Lecture Plan:

Lecture No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1	Introduction and Course Hand-out briefing		Lecture	NA	NA
2	Introduction of production and operations management.	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	In Class Quiz (Not Accounted)
3	**Forecasting**: importance, use and types of forecast technique	To understand the managerial responsibility for Operations, even when production is outsourced..	Lecture	1701.5	In Class Quiz
4	Correlation analysis and seasonality	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	End Term
5	Forecast control	To develop skills in solving production and operation management problems;	Lecture	1701.3	Home Assignment

6	**Product Development and Design**: an introduction	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	End Term
7	Factors affecting product development and design	To understand the managerial	Lecture	1701.5	
		responsibility for Operations, even when production is outsourced.			
8	Product analysis	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	In Class Quiz
9	Economic analysis and Standardization	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	End Term

10	Flow Diagrams and Man machine charts	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Class Quiz
11	**Capacity Planning:** an introduction	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	Mid Term I
12	Design capacity, System Capacity and System Efficiency	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	End Term
13	Factors affecting system capacity	To understand the managerial responsibility for Operations, even	Lecture	1701.5	Class Quiz
		when production is outsourced.			
14	Steps in capacity planning	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Mid Term 1

15	Decision tree analysis for capacity planning	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	End term
16	Breakeven analysis in planning capacity	To acquire a working understanding of the roles/functions of production management in the context of business enterprise.	Lecture	1701.2	Home Assignment
17	**Aggregate Planning:** an introduction	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Class Quiz
18	Pure and mixed strategies of aggregate planning	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	Mid Term 1
19	**MRP:** Introduction and its use		Lecture	1701.1	End Term
20	Product structure tree, MRP inputs & outputs, MRP logic	To recognize, appreciate, and perform the job of a competent	Lecture	1701.4	Class Quiz

		production or operation manager			
21	**Line balancing**: Meaning and determination of cycle time	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Mid Term 1
22	Theoretical minimum number of workstations		Lecture	1701.1	End Term
23	**Job Shop Scheduling**: an introduction and its importance	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	Class Quiz
24	Factors affecting job shop scheduling		Lecture	1701.1	Mid Term I
25	Index method,	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	End Term
26	Priority sequencing rules	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Class Quiz
27	FCFS and numerical		Lecture	1701.1	End Term

28	SPT and numerical examples	To recognize, appreciate, and perform the job of a competent production or operation manager	Lecture	1701.4	Class Quiz
29	EDD and numerical examples	To recognize, appreciate, and perform the job of	Lecture	1701.4	Mid Term II
		a competent production or operation manager			
30	Average job lateness	To develop skills in solving production and operation management problems;	Lecture	1701.3	End Term
31	Average number of jobs in the system	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz
32	**Inventory management:** Introduction	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	Mid Term II

33	Classification of inventories, Economic order quantity	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	Lecture	1701.1	End Term
34	Inventory control models	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz
35	Effect of quantity discount	To develop skills in solving production and operation management problems;	Lecture	1701.3	Mid Term II
36	Quality Control: Meaning of Quality, Quality assurance system,	To develop skills in solving production	Lecture	1701.3	End Term
		and operation management problems;			
37	Inspection and control of quality; Process control charts,	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz

38	Acceptance sampling, Concept of Six Sigma.	To develop skills in solving production and operation management problems;	Lecture	1701.3	Mid Term II
39	Reliability and Maintenance Planning:		Lecture	1701.1	End Term
40	Constant failure rate and Timedependent failure rate models for system components;	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz
41	System reliability determination;	To develop skills in solving production and operation management problems;	Lecture	1701.3	End Term
42	Types of maintenance.	To acquire a working understanding of the roles/functions of production management in the context of business enterprise;	Lecture	1701.2	Class Quiz

43	Queuing Model: Introduction,	To develop skills in solving production and operation management problems;	Lecture	1701.3	End Term
44	Markov Chains and Markov Processes,	To develop skills in solving production	Lecture	1701.3	Class Quiz
		and operation management problems;			
45	Birth-Death Processes,	To develop skills in solving production and operation management problems;	Lecture	1701.3	End Term
46	Simple Queueing Models M/M/-/-Queues.	To develop skills in solving production and operation management problems;	Lecture	1701.3	Class Quiz
47	Case Stduy-1		Lecture		
48	Case Stduy-1I		Lecture		

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
MC1761.1	To gain some ability to recognize use of certain quantitative methods to assist in decision making on operations management and strategy.	3							1					1		3
MC1761.2	To acquire a working understanding of the roles/functions of production management in the context of business enterprise;		2	2								2		1		3
MC1761.3	To develop skills in solving production and operation management problems;				2	2								1		3
MC1761.4	To recognize, appreciate, and perform the job of a competent production or operation manager						2		2	3				1		3
MC1761.5	To understand the managerial responsibility for			1						1	1			1		3

	Operations, even when production is outsourced,															

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

MECHATRONICS SYSTEM DESIGN | MC1702 | 3 Credits | 3 1 0 4

Session: July 17 – Nov 17 | Faculty: Surbhi Gupta | Class: Core (VII Sem)

UUU. Introduction: This course introduces the approach to design mechatronics systems. This involves the synergistic knowledge of all mechatronics components. The course takes you step by step to design a complete mechatronics system involving individual domain knowledge. The course assumes a prior knowledge on mechatronics components, control algorithms and mechanical mechanisms.

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

[1331.29]. To revise different components of mechatronic systems

[1331.30]. To learn different components of system design

[1331.31]. To perform mathematical modelling of mechatronics system

[1331.32]. To design control algorithms for mechatronic systems

[1331.33]. To implement and simulate designs using software tools

[1331.34]. To interpret and solve practical problems with knowledge of MSD

WWW. Program Outcomes and Program Specific Outcomes

[PO.13]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

[PO.14]. 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.15]. 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.16]. 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.17]. 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.18]. 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.19]. 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.20]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

[PO.21]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.22]. 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.23]. 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.24]. 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.

11. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.
12. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.
13. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

XXX. 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.	

YYY. Syllabus

Introduction: Mechatronics Design process, Design Parameters, Traditional and Mechatronics designs – Advanced approaches in Mechatronics, Industrial design, and ergonomics, safety. System Modelling: Introduction-model categories-fields of application-model development-model verification-model validation-model simulation-design of mixed systems-electro mechanics design-model transformation- domain-independent description forms-simulator coupling. Actuators: Characteristics and applications of the Mechanical, electrical, Hydraulic and pneumatic actuator, shape memory alloys and their limitations. Sensors

and transducers for motion measurement. Control parameters and system objectives, Mechanical configurations, popular control system configurations. Design with linear slides, Motion control Algorithms: significance of feedforward and feedback control loops, shortfalls, Architecture of Intelligent Machines: System design Classification, Motion control aspects of Design. Human and Machine, Machine Interfacing devices and strategy, Machine Vision: Feature and Pattern Recognition methods, concepts of perception and cognition in decision making. Case study: case study 1 and case study 2.

ZZZ. Text Books

1. W. Bolten, *Mechatronics*, Addison Wesley Longman Ltd, 1999.

2. D. Shetty & R. Kolk, *Mechatronics System Design*, PWS Publishing.

Reference Books

1. M. B. Histand and D. G. Alciatore, *Designing Intelligent Machines*, Open University, London.
2. D.A. Bradley and others, *Mechatronics*, Chapman & Hall Publications.
3. D. Nesculescu, *Mechatronics*, Pearson Education Pvt. Ltd. 2002.
4. C.W. Desi, *Control sensors and actuators*, Prentice Hall Publications.
5. Alcitore, Michael B. Histand, David G. Alciatore, *Introduction to mechatronics and measurement systems*, Tata MCGraw Hill**.**

AAAA. 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
2,3	Components of mechatronics	Introductory revision to different components of mechatronics	Lecture	1706.1	In Class Quiz (Not Accounted)
4	Sensors	Revision of sensors	Lecture	1706.1	In Class Quiz Sessional exam I End Term
5-6	Actuators	Revision of actuators	Lecture	1706.1	Home Assignment Sessional exam I End Term
7	Processors	Revision of processors	Lecture	1706.1	In Class Quiz Sessional exam II End Term

8,9	Signal acquisition	Revision of signal acquisition strategies	Lecture, Activity	1706.1	Class Quiz Sessional exam II End term
10,11	Control system	Revision of control algorithms	Lecture	1706.1	Home Assignment Class Quiz Sessional exam II End Term
12-15	System modelling	Introduction to various concepts of system modelling	Lecture	1706.2, 1706.4	Class Quiz Sessional exam II End Term
16-20	Mechanical modelling	Mathematical derivation of mechanical components	Lecture, Activity	1706.3	Class Quiz Sessional exam II End Term
21-25	Model simulation	Simulation using CAD	Lecture, activity	1706.3, 1706.5	Class Quiz End Term
26 - 30	Control models	Mathematical modelling for control implementation	Lecture	1706.3	Class Quiz Mid Term II End Term
31-35	Model simulation	Simulation using MATLAB	Lecture, activity	1706.3, 1706.5	Class Quiz End Term
36-45	Example	Solving example designs of mechatronic systems	Flipped class, activity	1706.5, 1706.6	Class Quiz End Term
46-48	Advantage and disadvantages	Describe the requirements of MSD	Lecture	1706.6	Class Quiz End Term
49-50	Conclusion	Conclude the course	Lecture	1706.1	NA

BBBB. 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
MC 1706.1	To revise different components of mechatronic systems	1		1		3				1			1	1	2	2
MC 1706.2	To learn different components of system design	1	2	2		2	1	1	1			1	1	1	1	1
MC 1706.3	To perform mathematical modelling of mechatronics system	1	3	3	2	2								2		3
MC 1706.4	To design control algorithms for mechatronic systems	1	3	2	2	2								2	2	1
MC 1706.5	To implement and simulate designs using software tools	1	1	3	2	2							1	1	1	1
MC 1706.6	To interpret and solve practical problems with knowledge of MSD	1	3	1	2	2								1	1	1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Micro Electro Mechanical Systems (MEMS)| MC1703 | 4 Credits | 4 0 0 4

Session: July 17 – Nov 17 | Faculty: Anil Sharma | Class: Departmental Elective

H. Introduction: The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques. This enables them to design, analysis, fabrication and testing the MEMS based components. And to introduce the students various opportunities in the emerging field of MEMS.

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

[MC1755.1] Analyse the working principles of currently available micro sensors, actuators, motors, valves, pumps, and fluidics used in microsystems.
[MC1755.2] Apply different scaling laws that are used extensively in the conceptual design of micro devices and systems.
[MC1755.3] Analyse different materials available for MEMS based processes and select materials for various MEMS devices.
[MC1755.4] Assess various techniques used in micro-fabrication processes and applications. Students will be able to differentiate between the positive and negative consequences of certain processes that are pertinent to microsystems.
[MC1755.5] Evaluate a micromachining technique, such as bulk micromachining and/or surface micromachining for the fabrication of specific MEMS device considering its working principle to enhance employability skills.

I. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.49]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.50]. 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.51]. 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.52]. 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.53]. 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.54]. 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.55]. 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.56]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.57]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.58]. **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.59]. **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.60]. **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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

J. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	20
	Sessional Exam II (Closed Book)	20
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	10
End Term Exam (Summative)	End Term Exam (Closed Book)	50
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
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.	

K. SYLLABUS

Introduction to MEMS and Microsystems: Products, Evolution of micro-fabrication, microelectronics, miniaturization, application in the automotive and other industries, Working principles of Microsystems: Micro sensors , Micro actuation, Scaling laws in miniaturization: Scaling in geometry, Scaling in rigid body dynamics, Scaling in electrostatic, electromagnetic forces, Scaling in electricity, Scaling in heat transfer and fluid mechanics, Materials for MEMS and microsystems: Substrates and wafers, Silicon as a substrate material, silicon compounds, silicon piezo-resistors, Gallium arsenide, Quartz, Polymers, Packaging materials, Problems, Microsystems fabrication Processes: Photo lithography, Ion implantation, Diffusion, Oxidation, Chemical vapor deposition, Physical vapor deposition, Deposition by Epitaxy, Etching, Problems, Micro-manufacturing: Bulk manufacturing, Surface micromachining, LIGA process, Microsystems Design: Design consideration, Process design, Mechanical design, Design of a silicon die, Design of microfluidic Network system. Case studies.

L. Text Book :

1. T. R. Hsu, MEMS and Microsystems - Design and Manufacturing, Tata McGraw Hill.
2. Chang Liu, Foundations of MEMS, Pearson Education – 2012.

M. References :

1. W. Menz, J. Mohr, O. Paul, Microsystem Technology, Wiley Publications, 2001.
2. M. Gad-el-Hak, The MEMS Handbook, CRC Press, 2002.
3. Marc J. Madou, Fundamentals of Micro fabrication: The Science of Miniaturization, CRC Press, 2002.

Web – edX course on MEMS and Micro-fabrication

N. Lecture Plan:

Lecture S.no.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
L1	Introduction to MEMS & Microsystems	NA	Lecture, Presentation	CO.1	NA
L2	Introduction to Microelectronics and micro sensors, actuators	Explore the scope of MEMS in various industries. Assess the working principles of currently available micro sensors, actuators	Lecture, Presentation	CO.1	In class quiz
L3	Evaluation of MEMS, Micro sensors, Market Survey		Presentation	CO.1	In class quiz
L4	Application of MEMS		Lecture	CO.1	Sessional Exam
L5	Working principles of Microsystems: Micro sensors , Micro actuation		Lecture, Presentation	CO.1	Sessional Exam
L6	Scaling laws in miniaturization	Learn about the effects of different phenomenon at micro scale	Lecture, Presentation	CO.2	Home assignment
L7	Scaling laws in miniaturization (Contd.)		Class activity	CO.2	Home assignment
L8	MEMS Materials	Analyse different materials available for MEMS based processes.	Lecture, presentation	CO.3	Home assignment
L9	MEMS Materials Properties		Lecture, presentation	CO.3	Sessional Exam
L10	MEMS fabrication – Introduction	Understand the basic principles and applications of micro-fabrication processes, such as photolithography, ion implantation, diffusion, oxidation, CVD, PVD, and etching.	Lecture, presentation	CO.1, CO.4	Sessional Exam
L11	Microsystems fabrication Processes - I		Lecture	CO.1, CO.4	In class quiz
L12	Microsystems fabrication Processes – II		Lecture, presentation	CO.1, CO.4	In class quiz
L13	Microsystems fabrication Processes (Contd.)		Presentation	CO.1, CO.4	Sessional Exam
L14	Micro-manufacturing : Bulk manufacturing, examples	Identify a micromachining technique, such as bulk micromachining and/or surface micromachining for a specific MEMS fabrication process.	Presentation	CO.5	Sessional Exam
L15	Micro-manufacturing : surface manufacturing, examples		Lecture, presentation	CO.5	Sessional Exam
L16	Micro-manufacturing : LIGA Process		Lecture, presentation	CO.5	In class quiz

L17	Etch Stop Techniques and Microstructure	Understand the pros and cons of different micro manufacturing process	Presentation	CO.5	In class quiz
L18	Surface and Quartz Micromachining		Presentation	CO.5	In class quiz
L19	Fabrication of Micro machined Microstructure		Lecture	CO.5	In class quiz
L20	Micro-stereolithography		Lecture	CO.5	In class quiz
L21	Microsystems Design: Design consideration, Process design		Lecture	CO.5	Sessional Exam
L22	Mechanical design, Design of a silicon die		Lecture, presentation	CO.5	Sessional Exam
L23	Design of microfluidic Network system	Understand the working principles of currently available micro sensors, actuators with applications. Resource planning for a given microsystem fabrication and application Identify how physical and chemical phenomena affect micro systems for various applications	Lecture	CO.4	In class quiz
L24	Microsystems Design problems		Lecture, presentation	CO.4	In class quiz
L25	MEMS Micro sensors (Thermal)		Lecture	CO.4	In class quiz
L26	Micro machined Micro sensors (Mechanical)		Lecture, presentation	CO.4	Sessional Exam
L27	MEMS Pressure and Flow Sensor		Lecture, presentation	CO.4	Sessional Exam
L28	MEMS Inertial Sensors		Class activity	CO.1, CO.4	End Semester Exam
L29	MEMS Micro accelerometers		Class activity	CO.1, CO.4	End Semester Exam
L30	Piezo resistive Accelerometer Technology		Lecture	CO.1, CO.4	End Semester Exam
L31	MEMS Capacitive Accelerometer		Lecture, Class activity	CO.1, CO.4	Home Assignment
L32	MEMS Capacitive Accelerometer Process		Class activity	CO.1, CO.4	Home Assignment
L33	MEMS Gyro Sensor		Class activity	CO.1, CO.4	Home Assignment

L34	Interface Electronics for MEMS		Lecture	CO.1	Student presentation
L35	Introduction to Bio-MEMS	Explore recent advancements in the field of MEMS and devices and future aspects.	presentation	CO.1	Student presentation
L36	Case Studies 1		Presentation	CO.1	Student presentation
L37	Case Studies 2		Lecture, presentation	CO.1	Student presentation
L38	Case Studies 3		Lecture, presentation	CO.4	Student presentation
L39	Signal mapping and transduction		Class activity	CO.1	Student presentation
L40	Revision	NA	Class activity	CO.1	NA

O. 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
MC1755.1	Analyse the working principles of currently available micro sensors, actuators, motors, valves, pumps, and fluidics used in microsystems.	2	3		1		1							1	1	1
MC1755.2	Apply different scaling laws that are used extensively in the conceptual design of micro devices and systems.	2	3	1										1	2	1
MC1755.3	Analyse different materials available for MEMS based processes and select materials for various MEMS devices.	2	2		1									2		1
MC1755.4	Asses various techniques used in micro-fabrication processes and applications. Students will be able to differentiate between the positive and negative consequences of certain processes that are pertinent to microsystems.	1	2		2		2	1						2		1
MC1755.5	Evaluate a micromachining technique, such as bulk micromachining and/or surface micromachining for the fabrication of specific MEMS device considering its working principle.	2		2	1	3										1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Intelligent Controller | MC 1704 | 4 Credits | 3 1 0 4

Session: July 17 – Nov 17 | Faculty: Ashok Kumar Kumawat | Class: Core

P. **Introduction:** This course is offered by Dept. of Mechatronics Engineering as a core subject, targeting students who wish to pursue research & development in industries or higher studies in field of fuzzy logic, artificial neural network, and genetic algorithms. The course focuses on providing an introduction to the emerging area of intelligent control and optimization using a control-engineering approach. Students are expected to have background knowledge on intelligent controllers for a better learning.

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

[1331.35]. Understand the inspiration behind and requirement of the intelligent control systems.

[1331.36]. Understand the intelligent control algorithms based on neural network, fuzzy logic and genetic algorithms.

[1331.37]. Comprehend the mathematical basis of various soft computing techniques and relate them for various control applications.

[1331.38]. Implement intelligent modelling and optimization of control systems with software tool such as MATLAB or Python.

[1331.39]. Proficient in developing intelligent systems through case studies and simulation examples.

R. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.25]. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

[PO.26]. **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.27]. **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.28]. **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.29]. **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.30]. **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.31]. **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.32]. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

[PO.33]. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.34]. 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.35]. 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.36]. 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.

14. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.
15. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.
16. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

S. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	20
	Sessional Exam II (Closed Book)	20
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	10
End Term Exam (Summative)	End Term Exam (Closed Book)	50
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
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.	

T. SYLLABUS

FUNDAMENTALS: Fundamentals of Artificial Neural Networks, McCulloch – Pitts model, Activation functions, Feed forward and feedback networks, learning rules – Hebbian, Perceptron, delta, Widrow-Hoff, winner take all, SINGLE-LAYER FEED FORWARD NETWORKS: Classifiers, Decision regions, Discriminant functions, minimum distance classification, multi category discrete perceptron training algorithm, MULTI-LAYER FEED FORWARD NETWORKS: Linearly non-separable pattern classification, generalized delta learning rule, error back propagation training algorithms, SINGLE LAYER FEEDBACK NETWORK: Hopfield network, Boltzman machine, associative memories, performance analysis of energy function reduction, Bi-directional associative memory, APPLICATION: APPLICATION OF NEURAL NETWORKS: Control applications, Character recognition, FUZZY CONTROL: Introduction to Fuzzy control, membership function, classical sets & fuzzy sets, fuzzy set operations, Fuzzy relations, extension principles, Linguistic variables, Fuzzy IF_THEN statements, Inference rules, CONTROLLERS: Fuzzy knowledge based controllers [FKBC], structure of FKBC, Fuzzification, membership function evaluation using neural networks, genetic algorithms, inductive reasoning, DEFUZZIFICATION: Defuzzification methods, Application of fuzzy logic to control systems, Introduction to fuzzy-neural systems, Familiarization with MATLAB Fuzzy logic & neural network Toolbox.

TEXT BOOKS

1. Jacek M. Zurada, Introduction to Artificial Neural Networks, Jaico Publications, 1997.
2. Timothy J. Ross, Fuzzy logic with engineering applications, McGraw Hills Publications, 1997

REFERENCE BOOKS.

1. Yegnanarayana, Artificial Neural Networks, PHI Learning Publications, 2001.
2. Yager & Filev, Essentials of fuzzy modeling and control, Wiley, 1994.
3. Chin-Teng-Lin & C. S. George Lee, Neural Fuzzy Systems, Prentice Hall Publications, 1996.

U. 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
2,3	Introduction to intelligent controller	Understanding the requirement and inspiration for intelligent control	Lecture	1704.1	In Class Quiz
4,5	ANN- neural models- Mc-culloh pitt model	Introduction to ANN and neural models	Lecture	1704.1,2	In Class Quiz Sessional exam I End Term
6,7	ANN - Activation functions	Understanding ANN functionality	Lecture, activity	1704.2,3	Home Assignment Sessional exam I End Term
8,9	ANN – introduction to architectures	Understanding of the importance of ANN architectures	Lecture	1704.2	In Class Quiz Sessional exam I End Term
10-14	Learning rules	Get inside understanding of how neural network works	Lecture, Activity	1704.2,3,4	Class Quiz Sessional exam II End Term
15-18	Practical aspect of ANN and its utilisation	Will understand and apply ANN with simulation	Lecture, Activity	1704.2,4,5	Class Quiz Sessional exam II End term
19, 20, 21	Application of ANN in control system	Introduction and case study for ANN in control system	Lecture, Flipped Class	1704.2,5	Home Assignment Class Quiz Sessional exam II End Term
22,23	Introduction to fuzziology/ fuzzification	Realise the need of fuzzy system	Lecture	1704.2	Class Quiz Sessional exam II End Term
24-26	Mathematical modelling- Theory	Understand the maths behind fuzzy application	Lecture	1754.2	Class Quiz Sessional exam II End Term
27-29	Mathematical modelling- Practical	Practical analysis of maths for fuzzy system	Activity, flipped class	1754.2,3,4	Class Quiz End Term
30-33	Fuzzy control	Application of fuzzy methods in control system	Lecture	1704.3	Class Quiz End Term
34-37	Practical aspects of fuzzy controller	See the practical aspects of the fuzzy theory and how to apply	Lecture, Activity	1704.3,4	Class Quiz End Term
38,39	Integration of ANN-Fuzzy	Introduction to integration of two intelligent systems	Lecture	1704.2	Class Quiz End Term
40-41	Computation behind ANN-fuzzy systems	Describe mathematics and logic behind success of ANN-Fuzzy systems as well as realize the drawbacks	Lecture	1754.3	Class Quiz End Term

42, 43, 44	Control aspect of ANN – fuzzy systems	Describe the application of ANN – fuzzy systems	Lecture	1704.3	Class Quiz End Term
45,46	Genetic algorithm	Understanding of basic fundamentals of genetic algorithm	Lecture	1704.2	Class Quiz End Term
47-50	Case studies	Involve in simulation analysis of practical systems	Activity	1704.5	Class Quiz End Term

V. 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
MC 1704.1	To understand the inspiration behind the intelligent control systems		1	1										1		
MC 1704.2	To have a basic understanding of neural network, fuzzy logic and genetic algorithms	1		1						1				1	2	
MC 1704.3	Learn the mathematical basis of various soft computing techniques	1		1										2	2	
MC 1704.4	Correlate theoretical and practical aspects of intelligent modelling, optimization and control of non-linear systems		1				2	1		1				2	1	
MC 1704.5	Experience in developing intelligent systems through case studies, simulation examples		1	1						1	1		1	1	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Computer Integrated Manufacturing | MC1705 | 4 Credits | 3 1 0 4

Session: JULY 17 – DEC 17 | Faculty: Nikhil Shrivas | Class: Departmental Core

A. INTRODUCTION: This course is offered by Dept. of Mechatronics Engineering as a core course. This course is designed to give a clear understanding of the concepts underlying the computer integrated manufacturing, group technology, FMS and CNC machines.

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

[MC 1705.1] To understand the basics of NC, CNC, and DNC and developing CNC codes for different machining operations.

[MC 1705.2] To understand the basics of Group Technology, Flexible Manufacturing Process and Computer Integrated Manufacturing and learn their areas of applications.

[MC 1705.3] To learn about industrial robot, design, kinematics, dynamics and applications.

[MC 1705.4] To analyse single station automated cell, automated transfer systems Line and to learn fundamentals of automated flow lines.

[MC 1705.5] To understand Computerized Manufacturing Planning Systems and Computer aided Process planning.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	20
	Sessional Exam II (Closed Book)	20
	Quizzes and Assignments	10
End Term Exam (Summative)	End Term Exam (Closed Book)	50
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
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. 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 classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS:

Numerical Control Production Systems: Development in Machine Tools, Components of NC Machine, Problem with conventional NC, CNC Machine, Classification, Advantages and disadvantages of CNC machine, Design consideration of CNC Machines, Methods of improving machine accuracy and productivity, Machine structure, Guideways, Spindle and Feed drives, Spindle Bearings,Interpolators, Control loops of CNC systems, Control loop of point to point systems, Control loop of contouring systems. CNC Toolings, CNC programming: Co-ordinate systems, CNC programming for Turning Center and Machining center by Manual method (word address format only), CNC programming with interactive graphics, Manual data input, Distributed Numerical Control, Adaptive Control Machining System, Automated Inspection and Testing, Industrial Robotics: Introduction to Robotics, Robot anatomy physical configurations, Manipulator Kinematics, Technical features, programming the robot, robot programming language, end effecters, work cell design, work cell control and interlock, robotic sensor, robotic applications, Group Technology , FMS and CIM: Part families –Part classification and coding, production flow analysis, machine cell design, benefits of group technology, Computer Integrated Manufacturing System, Types of Manufacturing System, Machine Tools and related equipment, Material Handling System, Automated Guided Vehicles, Analysis of Material Transport Systems, Automated Storage/Retrieval Systems, Analysis of storage systems, Single station manufacturing cells, Flexible Manufacturing System, FMS work station, Types of FMS Layouts, Computer control in CIM, Human labour in CIM, Benefits of CIM, Computerized Manufacturing Planning

Systems: Computer aided Process planning, Computer integrated planning systems, Material requirement planning,Capacity planning, shop floor control, factory data collection systems, automatic identification systems

Primary References:

1. M. Thomas Crandell, CNC Machining and Programming an Introduction, Industrial Press Inc., New York, 2002.

2. P. Groover Mikell, Automation, Production Systems, and computer Integrated manufacturing, Prentice Hall of India, New Delhi, 2003.

Secondary References:

1. K. Yoram, Ben and U. Joseph, Numerical Control of Machine Tools, Khanna Publishers, New Delhi, 2005.
2. Mikell P. Groover, and Emory W. Zimmers, Computer aided design and manufacturing, Prentice Hall of India, New Delhi, 2003.
3. P. Radhakrishnan, Computer Numerical Control Machines, New Central Book Agency Pvt. Ltd., Kolkata 2004 .
4. HMT Limited, Mechatronics, Tata McGraw Hill, New Delhi, 1998.
5. P.N Rao, CAD/CAM, Tata McGraw Hill, New Delhi, 2005.
6. James Madison, CNC Machining Hand Book, Industrial Press Inc, New York, 1996.
7. Smid Peter, CNC programming Hand book, Industrial Press Inc., New York, 2000.
8. K Yoram, Computer Control of Manufacturing Systems, and Computer Integrated Manufacturing, McGraw Hill Publications, Singapore, 1983.

Lecture Plan:

Lec. No	Topics	Session Objective	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1-2	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
3-4	Development in Machine Tools	To understand basics of machine tools	Lecture	CO.1	Class Quiz
5-7	Components of NC Machine, Problem with conventional NC, CNC Machine	NC, CNC and DNC fundamentals	Lecture/Flipped Class	CO.1	Home Assignment
8-9	CNC programming: Co-ordinate systems, Manual data input, Distributed Numerical Control,	CNC programming development	Lecture	CO.1	Class Quiz
10-11	CNC programming: Co-ordinate systems, Manual data input, Distributed Numerical Control,	CNC programming development	Lecture	CO.1	Home Assignment
13-16	Adaptive Control Machining System, Group Technology	Basics of adaptive control system and group technology introduction	Lecture	CO.2	Class Quiz

17-22	Part families – Part classification and coding, production flow analysis, Computer Integrated Manufacturing System,	Part classification and coding techniques	Lecture	CO.2	Home Assignment
23-25	Automated Storage/Retrieval Systems, Flexible Manufacturing System,	Industrial ASRS system and introduction to FMS	Lecture/Flipped Class	CO.3	Class Quiz
26-30	Introduction to Robotics, Robot anatomy physical configurations, Manipulator Kinematics,	To understand the robot design	Lecture	CO.4	Home Assignment
31-34	Technical features, programming the robot, robot programming language, end effecters, work cell design, work cell control and interlock, robotic sensor, robotic applications,	Learn about robot kinematics, programming	Lecture	CO.4	Class Quiz
35-37	Computerized Manufacturing Planning Systems: Computer aided Process planning,	Learn about CAPP	Lecture	CO.5	Home Assignment
38-40	Computer integrated planning systems, factory data collection systems, automatic identification systems.	How the CAPP and factory data are integrated	Lecture	CO.5	Home Assignment

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

CO	STATEMENT	CORRELTION 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
MC1705.1	To understand the basics of NC, CNC, and DNC and developing CNC codes for different machining operations.	2	3	2										1	1	
MC1705.2	To understand the basics of Group Technology, Flexible Manufacturing Process and Computer Integrated Manufacturing and learn their areas of applications.	2	3	1										1	1	
MC1705.3	To learn about industrial robot, design, kinematics, dynamics and applications.	2	2	3			2			2				2	2	
MC1705.4	To Analyse single station automated cell, automated transfer systems Line and to learn fundamentals of automated flow lines.	1	2	2	2							2		2	1	
MC1705.5	To understand Computerized Manufacturing Planning Systems and Computer aided Process planning.	2		2	1	3						2		1	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Lab Course Hand-out

Mechatronics Lab| MC 1730 | 1 Credits | 0 0 2 1

Session: July 17 – Nov 17 | Faculty: Mr. Nikhil Vivek Shrivas/Mr Ashok Kumar Kumawat | Class: B. Tech VII Sem

CCCC. Introduction: This course is offered by Dept. of Mechatronics Engineering as a lab, targeting students who wish to pursue research & development in industries or higher studies in field of Automation Engineering, including Embedded systems, Robotics, and other advanced systems. Offers hands-on experience on varied mechatronics systems and simulation platforms.

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

[1331.40]. Understand and simulate applications of mechatronics elements in system automation
[1331.41]. Implement control algorithms on various types of motors through embedded platforms.
[1331.42]. Able to use MATLAB, SIMULINK and NI software.
[1331.43]. Apply the knowledge for design and optimisation of mechatronics systems

EEEE. 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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

FFFF. 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	

GGGG. Syllabus

HHHH. L

Design of fluid power circuit to control a double action cylinder for displacement velocity, force and direction, Design of an electro pneumatic circuit to control a double acting cylinder, Application of hydraulic simulation software based on cad system, to designControl circuits for automated functioning, Application of pneumatic simulation software based on Cad systemfor design of control circuits for automated functioning, Application of servo motor using PLC for controller interface and servo operation, Application of DCmotor using PLC position control and speed control, Application of software for driving stepper motor in full step resolution mode,half step resolution mode and milli step resolution mode, Use of Robotic

trainer to study characteristics of proximity sensing and vision sensing, Use of Robotic trainer to study the methods of achieving speed control,displacement control, in two and three dimensional space with reference to six degrees of freedom.

Text Books:

1. C.W. Desi, Control, sensors and actuators, Prentice Hall Publications.
2. Alcitore, Michael B. Histand, David G. Alciatore, Introduction to mechatronics and measurement systems, Tata MCGraw Hill.

IIII. Lecture Plan:

Lab No	**Name of the Experiment**	**Experiment Outcome**	**Type of Expt**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Demonstration Program	To acquaint and clear teachers expectations and understand student expectations	Live Demo	NA	NA
2	Study of simple RLC circuit and comparison between physical model and transfer-function model using SIMULINK	To simulate in basic circuits	HandsOn	1732.1 1732.3	Observational Data, Viva-Voce
3	Study of microcontroller, implementing logics and accessing its peripherals such as LEDs and switches using SIMULINK toolbox	To use SIMULINK to operate embedded platforms	HandsOn	1732.2 1732.3	Observational Data, Viva-Voce
4	Position control for stepper motor with microcontroller using MATLAB/SIMULINK.	To use SIMULINK to operate embedded platforms	HandsOn	1732.2 1732.3	Observational Data, Viva-Voce
5	Study of simple PID control and compare between analog circuit model and transfer-function model using SIMULINK	To simulate basic PID operations	HandsOn	1732.1 1732.3	Observational Data, Viva-Voce
6	Design of P and PD controller for Armature-controlled DC motor using MATLAB/SIMULINK	To simulate control action for motors	HandsOn	1732.1 1732.3	Observational Data, Viva-Voce
7	Design of PI and PID controller for Armature-controlled DC motor using MATLAB/SIMULINK	To simulate control action for motors	HandsOn	1732.1 1732.3	Observational Data, Viva-Voce
8	Study of DC Servomotor Position Controller for P and PI Control with microcontroller using MATLAB/SIMULINK	To simulate control action for motors	HandsOn	1732.1 1732.3	Observational Data, Viva-Voce

9	Study of myoelectric signal acquisition using LabVIEW environment.	To operate myelectric signal to operate mechatronics systems	HandsOn	1732.4	Observational Data, Viva-Voce
10	Design and verification of P and PD control law for a DC motor (Quansar Qube) using LabVIEW environment.	To acquaint with control algorithms with mechatronics systems	HandsOn	1732.4	Observational Data, Viva-Voce
11	Modelling of a rotary pendulum (Quansar Qube) and implementation of P and PD controller in myRIO using LABVIEW environment	To acquaint with control algorithms with mechatronics systems	HandsOn	1732.4	Observational Data, Viva-Voce
12	Design of PLC logic for variable frequency drive control of three phase Induction Motor	To acquaint with use of PLC for operating mechatronics systems	HandsOn	1732.4	Observational Data, Viva-Voce
13	Design and simulation of hydraulic circuit to control a single acting cylinder using automation studio/SIMULINK	To understand about use of hydraulic systems	HandsOn	1732.4	Observational Data, Viva-Voce

JJJJ. 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
MC1532.1	Understand and simulate applications of mechatronics elements in system automation	3	1	1	1	1			1					1		
MC1532.2	Implement control algorithms on various types of motors through embedded platforms.		2	1		3								1	2	
MC1532.3	Able to use MATLAB, SIMULINK and NI software.		2	1	2									2		
MC1532.4	Apply the knowledge for design and optimisation of mechatronics systems		3	2	1	1								2	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile, Mechanical and Mechatronics

Department of Mechatronics Engineering
Course Hand-out

CIM & automation Lab| MC1731 | 1 Credits | 0 0 2 1

Session: 2017-2018 | B.Tech. VII Semester

A. **Introduction:** Due to the rapid advances in technology, all industrial processing systems, factories, machinery, test facilities, etc. turned from mechanization to automation. A mechanization system needs human intervention to operate the manual operated machinery. As new and efficient control technologies evolved, automation control is being driven by the need for high accuracy, quality, precision and performance of industrial processes. Automation is a step beyond the mechanization which makes use of high control capability devices for efficient manufacturing or production processes.

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

[MC1733.1] Recognize different circuit designing techniques and judge the best way to achieve the output with circuit for a particular condition of automation

[MC1733.2] Recall different automated motion for different types of applications, choose and test various valves for the circuit developed to imitate actual motion required for automation thus increasing entrepreneurship skills.

[MC1733.3] Experiment using different valves for circuit, analyses the circuit and correlate with working of valves.

[MC1733.4] Modify the circuit using different valves and PLC to control the final actuator motion using electrical controls used in industrial scenario thus enhancing employability skills.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Plan:

Criteria	**Description**	**Maximum Marks**
Internal Assessment (Summative)	Laboratory Sessions	60
End Term Assessment (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

Pneumatics: Single cycle automation of multiple cylinders using cascading method; Intermediated positioning of a double acting cylinder ; Use of pneumatic counter; Use of pressure sequence valve; Use of back pressure valve; Use of pneumatic PLC for automation for single and multiple cycle; Application of AND/ OR Logic; Electro-pneumatics AND/ OR logic; single cycle automation using relay; ON and OFF delay timer application for solenoid actuation; Use of double solenoid valve with capacitive sensors (Use plastic or metal cam for sensing); Use of double solenoid valve and electrical limit switch. Use of PLC for multi-cycle and sequential operation of actuators.

Text Books:

1. Pneumatics Systems: By S. R Majumdar
2. Industrial Automation & robotics :By A. K Gupta & S. K. arora

Reference Books:

3. Advance Level Text book : Janatics
4. Advance Level Work book : Janatics
5. Waller D. and Werner H., Pneumatics Workbook Basic Level, Festo Didactic GMBH & Co, Germany, 1993.

KKKK. Lecture Plan:

Lab No	Name of the Experiment	Experiment Outcome	Type of Expt	Corresponding CO	Mode of Assessing the Outcome
1.	**Experiment 1:** Application of cascading method for single cycle automation of multiple cylinders using (Sequence of motion :A+B+B-A-).	To acquaint the students with pneumatic circuit designing techniques.	Live Demo	1733.1 1733.2	Verification/Implementation of circuit, Viva-Voce
2	**Experiment 2:** Use of spring centered pilot operated valve for manual intermediated positioning of a double acting cylinder in forward stroke and automatic retraction in return stroke	To acquaint the students with locking of cylinder in a position	Live Demo/Hands ON	1733.2 1733.3	Verification/Implementation of circuit, Viva-Voce
3	**Experiment 3:** Application of pneumatic counter for counting number of cycles of a cylinder.	To acquaint with usage of counters in mass production	Hands On	1733.2 1733.3	Verification/Implementation of circuit, Viva-Voce
4	**Experiment 4:** Demonstration of a pressure sequence valve for single cycle automation of a double acting cylinder	To acquaint with sequential operation automation in industries	Hands On	1733.2 1733.3	Verification/Implementation of circuit, Viva-Voce
5	**Experiment 5:** Use of back pressure valve for single cycle automation of a double acting cylinder	To acquaint with sequential automation using back pressure valve.	Hands On	1733.2 1733.3	Verification/Implementation of circuit, Viva-Voce
6	**Experiment 6:** Use of pneumatic PLC for single cycle automation of multiple cylinders (Sequence of motion A+B+A-B-)	To acquaint with the usage of pneumatic PLC	Hands On	1733.2 1733.3 1733.1	Verification/Implementation of circuit, Viva-Voce
7	**Experiment 7:** Use of pneumatic PLC for multi cycle automation of multiple cylinders (Sequence of motion A+B+A-B-)	To acquaint with the use of pneumatic PLC for automation	Hands On	1733.2 1733.3 1733.1	Verification/Implementation of circuit, Viva-Voce
8	**Experiment 8:** Application of AND/ OR Logic using two manual controls for forward stroke of a double acting cylinder and using relay for actuation.	To acquaint with automation through specific valves	Hands On	1733.2 1733.3	Verification/Implementation of circuit, Viva-Voce

9	**Experiment 9:** Demonstration of electro-pneumatic operation of two double acting cylinders in sequence A+B+B-A-	To acquaint Electro pneumatic automation	Hands On	1733.2 1733.3	Verification/Implementation of circuit, Viva-Voce
10	**Experiment 10:** Verifying the use of On and OFF delay timer in operation of a double acting cylinder using double solenoid valve for single cycle.	To acquaint with techniques for designing of pneumatic circuits and its automation through specific valves	Hands On	1733.2 1733.3	Verification/Implementation of circuit, Viva-Voce
11	**Experiment 11:** Use of capacitive sensors for operation of a double acting cylinder using double solenoid valve	To acquaint with automation circuit based on sensors	Hands On	1733.2 1733.3	Verification/Implementation of circuit, Viva-Voce
12	**Experiment 12:** Use of electric limit switch for multi cycle operation of a double acting cylinder using double solenoid valve	To acquaint with automation using electrical limit switch	Hands On	1733.2 1733.3	Verification/Implementation of circuit, Viva-Voce
13	**Experiment 13:** Use of PLC for multi cycle operation of a double acting cylinder	To understand the PLC for pneumatic circuit automation	Hands On	1733.3 1733.4	Verification/Implementation of circuit, Viva-Voce
14	**Experiment 14:** Use of PLC for operation of a two cylinders in sequence A+A-B+B-	To understand the PLC for pneumatic circuit automation	Hands On	1733.3 1733.4	Verification/Implementation of circuit, Viva-Voce

LLLL. 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
MC1733.1	Recognize different circuit designing techniques and judge the best way to achieve the output with circuit for a particular condition of automation.	3		2		1		3	2	2				2	1	1
MC1733.2	Recall different automated motion for different types of applications, choose and test various valves for the circuit developed to imitate actual motion required for automation thus increasing entrepreneurship skills.	3		3		1		3	2	2				2	1	
MC1733.3	Experiment using different valves for circuit, analyses the circuit and correlate with working of valves.	3		2		1		3	2	2				2	2	
MC1733.4	Modify the circuit using different valves and PLC to control the final actuator motion using electrical controls used in industrial scenario thus enhancing employability skills.	3		2		1		3	2	2				2	2	

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Modern Control System | MC1752 | 3 Credits | 3 0 0 3

Session: Jan 18 – May 18 | Faculty: Princy Randhawa | Class: Program Elective

A. INTRODUCTION: This course is offered by Dept. of Mechatronics Engineering as a Program Elective. This course covers the design and analysis of sampled data systems and provides a theoretical basis for applying the methods of state space and multivariable systems design. It also develops an understanding of how interactions between and within loops can be handled by design.

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

[MC1752.1] Outline the basics of linear and nonlinear systems background with emphasis on state space techniques and writing the state space equation for electrical, mechanical and analogous systems.

[MC1752.2] Interpret how the time response of linear time-invariant systems are linked to state space parameter and the connection between transfer function and state-space models. Understand the stability concept and its link to the transfer function pole locations and state space parameters.

[MC1752.3] Describe about the extending state-space analysis and gains an appreciation of recent advances in control Engineering such as pole assignment, observers design, introduction to optimal, adaptive and Identification techniques.

[MC1752.4] Analyse and learn why standard methods of analysis and design in linear systems are not applicable in Non-linear system. Methods suitable for nonlinear systems are introduced and their applications are explored to enhance entrepreneur skills

[MC1752.5] Recall the fundamental concepts of Digital Control Systems and to understand the design of Digital Controllers.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, Power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[**PSO.3].** Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

D. Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	15
	Sessional Exam II (Closed Book)	15
	In class Quizzes and Assignment on MATLAB for designing any system	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. 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 classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS:

Sampled Data Control Systems, Signal Reconstruction, sampling process, ZOH, mapping between s and z planes – pulse transfer functions – step response – stability analysis – Jury's stability test, Bilinear Transformation, Bode plot, Root Locus models for Discrete Time system, Diagonalization, State Transition Matrix, Solution of equation for discrete time system by recursion and z-transform method, Concepts of Controllability and Observability, pole placement by state feedback-Ackerman's Formula- State Observers, Properties of non-linear systems - common physical non-linearity - dead zone, relay, and saturation nonlinearities - phase plane method-singular points phase trajectories, Isocline Method , Liapunov's stability criterion.

F. Text Books:

Ogata, K., Modern Control Engineering, Prentice-Hall, [2002]
Hsu, J. C. & A. U. Meyer, Modern Control Principles and Applications, McGraw-Hill, [1968]

G. Secondary References:

Gopal, M., Modern Control System Theory, John Wiley Eastern Ltd. New Delhi, [1984]
Friedland, B., Control System Design, McGraw-Hill, [1986]
M.Gopal , "Digital Control and State Variable Methods" , Tata McGraw Hill New Delhi , 2005
Kuo, B.C., "Digital Control Systems", Oxford University press, 1992.
Ogata, K., State Space Analysis of Control Systems, Prentice-Hall, [1967]
Kuo, B. C., Automatic Control Systems, Prentice-Hall, [1987]
Slotine, J. E. & Weiping Li, Applied Nonlinear Control, Prentice-Hall, [1991]
Gibson, J. E., Nonlinear Automatic Control, McGraw-Hill, [1963]

Software:

MATLAB: Control and Simulink Tool Boxes, Math Works Inc.

H. Lecture Plan:

Lec. No	**Topics**	**Session Objective**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Introduction to State Space Representation, Difference between classical and Modern Control Theory, Advantage of State Space Analysis	To understand the importance of state space analysis	Lecture	CO.1 & CO.2	In Class Quiz (Not Accounted) End Term Mid Term 1
3,4	Definitions- State, State Variable, State vector, State space, State Trajectory, State Space Model of Linear System, State Space Representation of a System, State Diagram	Few definitions for understanding state space analysis	Lecture	CO.1 & CO.2	In Class Quiz
5,6	Introduction to Eigen values, Eigen vectors and its diagonalization	Physical meaning of the terms and its usage	Lecture	CO.2	Home Assignment
7.-10	Computation of state transition matrix and its Properties, Numerical Practice	To practice numerical on state space analysis for finding eigen value,eigen,vector,STM mathematically	Lecture, Flipped Classroom	CO.3	In Class Quiz
11	Concepts of Controllability and Observability – linear time invariant systems	Study of Observer design and to check the stability of a system		CO.3	Home Assignment Class Quiz
12-14	Pole placement by state feedback, Introduction to State observers	Study of Observer design and to check the stability of a system	Lecture	CO.3	Class Quiz
15,16	Ackerman's Formula-Observers – Full order and reduced order, Numerical Practice	Analyse the system and check for stability and design full and state observer	Lecture	CO.3	Class Quiz
17	Introduction to Control System using MATLAB	Acquaint students with the brief overview of control system toolbox	Software Demonstration	CO.6	Class Quiz

18-19	How to write State Space Equation ,To Check controllability, Observability using MATLAB	To check for stability conditions by and analysing in MATLAB	Software Demonstration	CO.6	Class Quiz,
20	Introduction to Digital Control System, Sampling, Quantisation	What is digital control system and its importance in control system	Flipped Classroom	CO.5	Class Quiz End Term Mid Term 1
21	Sampled data Control System, Block Diagram Analysis of Sampled Data Control System	Study of ADC, sampler and Hold circuits	Lecture	CO.5	Class Quiz End Term Mid Term 1
22-24	Signal Reconstruction , Introduction to Zero Order Hold Circuit	Use of Zero order hold circuit and its transfer function	Lecture	CO.5	Class Quiz End Term Mid Term 2
25	Introduction to Z transform, Z and S domain Relationship	Acquaint about z transform and its properties and formulas	Lecture	CO.5	Class Quiz End Term Mid Term 2
26	Difference Equation, Z- transfer Function	How to use z transform in difference equation	Lecture	CO.5	Class Quiz End Term Mid Term 2
27-30	Stability Analysis by Bilinear Transformation Method, Jury Stability Test	Stability analysis for digital control system	Lecture	CO.5	Class Quiz End Term Mid Term 2
31-32	Introduction to Non Linear Control and its Properties, Common Physical Non Linearity- Dead zone, Saturation, Relay, Introduction to phase plane method	Non linearity's present in Non-linear system	Lecture	CO.4	End Term
33-35	Lyaponuv Stability Criteria, Lyapunov stability theorem, Singular Point, Phase trajectories, Numerical Practice	Stability Criteria for Non Linear System	Lecture	CO.4	Class Quiz End Term
36	Introduction to Robust Control, Optimal Control, Adaptive control	Introduction to Advanced Control system	Lecture	CO.3	Class Quiz End Term
37	Revision	NA	NA, Flipped Classroom	NA	NA

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

CO	STATEMENT	CORRELTION 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
MC 175 2.1	Outline the basics of linear and nonlinear systems background with emphasis on state space technique and writing the state space equation for electrical, mechanical and analogous systems.	3	2			2								3	2	
MC 175 2.2	Interpret how the time response of linear time-invariant systems are linked to state space parameter and the connection between transfer function and state-space models. Understand the stability concept and its link to the transfer function pole locations and state space parameters.	1			2	3								2		
MC 175 2.3	Describe about the extending state-space analysis and gains an appreciation of recent advances in control engineering such as pole assignment, observers design, introduction to optimal, adaptive and Identification techniques.	2		3	3	2								2	3	
MC 175 2.4	Analyse and learn why standard methods of analysis and design in linear systems are not applicable in Non-linear system. Methods suitable for nonlinear systems are introduced and their applications are explored.	3	2	2		3	1							2	1	

MC 175 2.5	Recall the fundamental concepts of Digital Control Systems and to understand the design of Digital Controllers.	3		1		2							1	2	2

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Seminar | MC 1780 | 3 Credits | 0 0 2 1

Session: July –Nov 17 | Faculty: Dr Manish Rawat/Dr Ram Dayal/ Jurwall. V | Class: VIIth Semester

W. Introduction: This course is offered by Dept. of Mechatronics Engineering, targeting students who wish to extend contribution in the field of research & development in industries or higher studies in field of Robotics, Manufacturing, Automation operations etc. Students get in depth knowledge by covering literature review in particular area and gives an introductory level knowledge on decision making at every level in product, process and material. Students are expected to have background knowledge on basic engineering problems, optimisation methods and mathematical formulation for a better learning.

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

[MC 1780.1] Compose literature review of recent advancement in area of Mechatronics such as control systems, automation, robotics, manufacturing etc.

[MC 1780.2] Journaling technical report writing, abstract and journal paper writing.

[MC 1780.3] Deducing new solution and approach to enhance the employability in product, process and material development.

[MC 1780.4] Predicting market demand and developing skills as per the trend of the market.

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]. Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

Y. Assessment Plan:

Criteria	Description	Maximum Marks
End Term Exam (Summative)	End Term Exam (presentation and report submission)	100
	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.	

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.

Z. SYLLABUS

Each student has to present a seminar, on any technical topic. The presentation time is a minimum of 30 minutes followed by a 10 minutes session for discussion/ question & answers; The seminar topic selected by the student must be approved by the authorized faculty of the department at least two weeks in advance; Each student has to submit to the department a seminar report at least three days before the day of seminar; Each student has to make the presentation with LCD projector

AA. 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
MC 1780 .1	Compose literature review of recent advancement in area of Mechatronics such as control systems, automation, robotics, manufacturing etc.	1	1	1	1	3	1	1	1	1	1	1	1	3	1	1
MC 1780 .2	Journaling technical report writing, abstract and journal paper writing.	1	2	2	1	3	1	1	1	1	3	1	2	3	1	1
MC 1780 .3	Deducing new solution and approach to enhance the employability in product, process and material development.	1	1	1	1	3	1	1	1	1	1	1	1	3	1	1
MC 1780 .4	Predicting market demand and developing skills as per the trend of the market.	1	1	1	1	3	1	1	1	1	1	1	1	3	1	1

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

BB. 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
MC 1780.1	Compose literature review of recent advancement in area of Mechatronics such as control systems, automation, robotics, manufacturing etc.	1	1	1	1	3	1	1	1	1	1	1	1	3	1	1
MC 1780.2	Journaling technical report writing, abstract and journal paper writing.	1	2	2	1	3	1	1	1	1	3	1	2	3	1	1
MC 1780.3	Deducing new solution and approach to enhance the employability in product, process and material development.	1	1	1	1	3	1	1	1	1	1	1	1	3	1	1
MC 1780.4	Predicting market demand and developing skills as per the trend of the market.	1	1	1	1	3	1	1	1	1	1	1	1	3	1	1

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering
Course Hand-out

Industrial Training | MC 1781 | 3 Credits | 0 0 1 0

Session: July17 –Nov 17 | Faculty: Dr. Manish Rawat | Class: VII Semester

CC. Introduction: This course is offered by Dept. of Mechatronics 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.

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

[MC 1781.1] Demonstrate competency in relevant engineering fields through problem identification, formulation, and solution.

[MC 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.

[MC 1781.3] Increase in employability by working at industrial project.

[MC 1781.4] Master the professional and ethical responsibilities of an engineer.

EE. 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] Apply the knowledge of basic sciences, analytical skills and modern computing tools to design, perform and analyze experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems.

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems.

FF. 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.	

GG. 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.

HH. 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
[MC 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
[MC 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
[MC 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
[MC 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

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

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechatronics Engineering

Course Hand-out

Major Project | Code: MC-1880 | 12 Credits | 0 0 0 12

Session: Jan. 18 – May 18 | Faculty: Ms. Princy Randhawa | Class: VIII Semester

A. Introduction:

This course is offered by Dept. of Mechatronics 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-

[MC1880.1]. Demonstrate a sound technical skill and knowledge of Mechanical Engineering for better employability.

[MC1880.2]. Plan, analyze, design and implement a hardware/simulation-based project and gather knowledge over the field of research and design about the proposed work.

[MC1880.3]. Demonstrate knowledge of contemporary issues in their chosen field of research.

[MC1880.4]. 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]. Apply the knowledge of basic sciences, analytical skills, and modern computing tools to design, perform and analyse experiments to meet desired goals within the given constraints.

[PSO.2]. Apply concepts of circuit analysis, analog and digital electronics, controls, electric drives, instrumentation, power systems, machine learning and artificial intelligence to design and automation of mechatronics systems

[PSO.3]. Use the principles of solid mechanics, fluid mechanics, and strength of materials, advanced functional materials and manufacturing processes to design, manufacture, and commissioning of mechatronics systems

B. Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Report Guide Presentation Viva	10 10 15 15
End Term Exam (Summative)	Presentation Viva EXT 1 EXT 2	10 10 15 15
	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
MC 1880 .1	Demostrate a sound technical skill and knowledge of Mechanical Engineering for better employability.	3			2	2	2		3			1	2	3	2	2
MC 1880 .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
MC 1880 .3	Demonstrate knowledge of contemporary issues in their chosen field of research.	3	2		2	1	2	2	3	2		2	2	2	1	3
MC 1880 .4	Communicate with engineers and the community at large in written and oral forms.	3				2	3	2	3	3	3	1	3	3	1	2

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