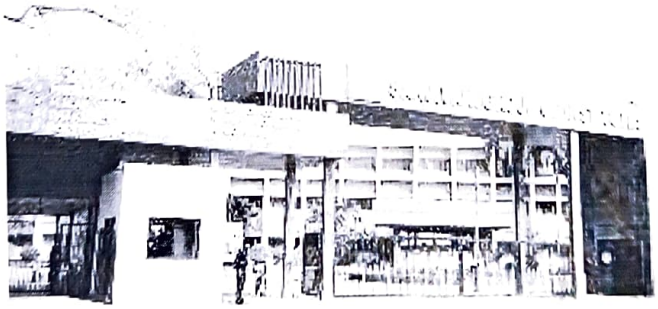
SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING, KOPARGAON

(An Autonomous Institute affiliated to SPPU, Pune)

DEPARTMENT OF MECHATRONICS ENGINEERING



COURSE STRUCTURE AND SYLLABUS- 2021

PATTERN

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON

(An Autonomous Institute affiliated to SPPU, Pune)

DECLARATION

We, the Board of Mechatronics Engineering, hereby declare that we have designed the Curriculum and syllabus of **B.Tech in Mechatronics Engineering 2021 PATTERN** as per the guidelines. Hence, we are pleased to submit and publish this Final Copy of the curriculum for the information to all the concerned stakeholders.

Submitted by

BoS Chairman

Approved by

Dean Academics

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON Approved

Director

Contents

Department of Mechatronics Engineering

VISION

Our vision is to develop mechatronics engineering professionals to cater to real time challenges of the globe through competency based Mechatronics Engineering Education.

MISSION

Our mission is:

- To offer competencies-based mechatronics engineering education and prepare learners to become innovators, entrepreneurs, and technocrats.
- To contribute to research and discovery in real time challenges of mechatronics engineering arenas.
- To train learners in the life skills, professional skills, citizen values, and ethics to upgrade their quality of life & professional careers.

Program Educational Objectives: (PEOs)

PEO1: Practice essential professional mechatronics engineering competencies that make them confident to develop high-quality mechatronics solutions in industrial, societal & research application domains.

PEO2: Engage and succeed gradually in managing, leading, and influential roles in their organizations and communities.

PEO3: Pursue higher studies, succeed in professional, and research careers.

PEO4: Start high-tech companies based on societal demands, and act as a technology leader.

Program Outcomes (POs):

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.

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.
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.
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.
7. **Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
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.
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.
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: (PSOs)

PSO-1: Ability to select appropriate mechanisms, sensors, actuators, drives, and control systems depending on application requirement in industrial automation, industry 4.0, and automotive mechatronics.

PSO-2: Ability to apply the concepts of integrated approaches of mechatronics engineering, software and hardware, robotics, controllers for design, development, analysis, and maintenance of mechatronics systems.

PSO-3: Ability to program controllers, PLCs, CNC machines, additive manufacturing machines, and industrial robots.

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON-423603

(An Autonomous Institute Affiliated to SPPU Pune)

DEPARTMENT OF MECHATRONICS ENGINEERING

COURSE STRUCTURE and SYLLABUS- 2021 PATTERN

FIRST YEAR B. TECH., SEM-I

(w.e.f. June 2021)

Board of Studies in Mechatronics Engineering, June 2021

LIST OF ABBREVIATIONS			
Abbreviation	**Full Form**	**Abbreviation**	**Full Form**
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SEMESTER-I

B.Tech. Programme in Mechatronics Engineering													**Programme Code: MK**
First year: Semester-I (Curriculum:2021-2022)													
Cat	**Abbriv.**	**Course Title**	**Teaching scheme/week**			**Credits L+T+P**	**Examination scheme**					
			L	**T**	**P**		**Theory**		**Theory**			**Total**
							CIA	**ESE**	**OR**	**PR**	**TW**	
BS	**BS1001**	**Engineering Mathematics I**	**3**	**1**		**4**	**40**	**60**				**100**
BS	**BS1002**	**Engineering Physics**	**3**			**3**	**40**	**60**				**100**
ES	**ES1001**	**Engineering Graphics**	**2**			**2**	**40**	**60**				**100**
ES	**ES1003**	**Basic Electrical and Electronics Engineering**	**2**			**3**	**20**	**30**				**50**
ES	**ES1008**	**Theory of Development and Engineering Thinking**	**2**			**2**	**20**	**30**				**50**
IP	**IP**	**Induction program**				**No Credit**						**-**
BS	**BS1102**	**Engineering Physics Lab**			**2**	**1**					**25**	**25**
ES	**ES1101**	**Engineering Graphics Lab**			**2**	**1**					**25**	**25**
ES	**ES1103**	**Basic Electrical and Electronics Engineering Lab**			**2**	**1**					**25**	**25**
HSMC	**HS1101**	**Language Proficiency Lab-I (English)**			**2**	**1**					**50**	**50**
ES	**ES1108**	**Theory of development and engineering thinking Lab**			**2**	**1**					**50**	**50**
		Total	**13**	**1**	**10**	**19**	**160**	**240**	**0**	**0**	**175**	**575**

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON-423603

(An Autonomous Institute Affiliated to SPPU Pune)

DEPARTMENT OF MECHATRONICS ENGINEERING

COURSE STRUCTURE and SYLLABUS- 2021 PATTERN

FIRST YEAR B. TECH., SEM-II

(w.e.f. June 2021)

Board of Studies in Mechatronics Engineering, June 2021

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Abbreviation	**Full Form**	**Abbreviation**	**Full Form**
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SEMESTER-II

B.Tech. Programme in Mechatronics Engineering													**Programme Code: MK**
First Year: Semester II (Curriculum:2021-2022)													
Cat	**Abbriv.**	**Course Title**	**Teaching scheme/week**			**Credits**	**Examination scheme**						
							Theory		**Theory**			**Total**
			L	**T**	**P**		**CIA**	**ESE**	**OR**	**PR**	**TW**	
BS	**BS2004**	**Engineering mathematics-II**	**3**	**1**		**4**	**40**	**60**				**100**
BS	**BS1003**	**Engineering chemistry**	**3**			**3**	**40**	**60**				**100**
ES	**ES1002**	**Computer Fundamentals and Programming**	**3**			**3**	**40**	**60**				**100**
ES	**ES1004**	**IT for Engineers**	**2**			**2**	**20**	**30**				**50**
HSMC	**HS2004**	**Physical Education and Sports**	**1**			**-**						**0**
MC	**MLC1001**	**Environmental Sciences**	**2**			**No Credit**						**Pass/ Fail**
ES	**ES1008**	**Engineering Mechanics**	**2**			**2**	**20**	**30**				**50**
BS	**BS1104**	**Engineering Chemistry Lab**			**2**	**1**					**25**	**25**
ES	**ES1102**	**Computer Fundamentals and Programming Lab**			**2**	**1**					**25**	**25**
HSMC	**HS2101**	**Language proficiency Lab-II (English)**	**2**	**1**		**1**					**50**	
ES	**ES1105**	**Workshop Practice**			**2**	**1**					**50**	**50**
HSMC	**HS2104**	**Physical Education and Sports**			**2**	**2**					**50**	**50**
ES	**ES1108**	**Engineering Mechanics Lab**			**2**	**1**					**50**	**50**
		Total	**16**	**1**	**12**	**21**	**160**	**240**	**0**	**0**	**225**	**625**

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON-423603

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DEPARTMENT OF MECHATRONICS ENGINEERING

COURSE STRUCTURE and SYLLABUS- 2021 PATTERN

SECOND YEAR B. TECH., SEM-I

(w.e.f. June 2020)

Board of Studies in Mechatronics Engineering, June 2021

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SEMESTER-III

B.Tech. Programme in Mechatronics Engineering **Programme Code: MK**

Second year: Semester-III (Curriculum:2021-2022)

Cat	Abbriv.	Course Title	Teaching scheme/week			Credits	Examination scheme					
							Theory		Theory			Total
			L	T	P		CIA	ESE	OR	PR	TW	
PC	PC3001	Basic Concepts of Mechatronics	4			4	40	60				100
PC	PC3002	Strength of Materials	3	1		4	40	60				100
PC	PC3003	Electrical Machines	3			3	40	60				100
PC	PC3004	Programming in Python	3			3	40	60				100
HSMC	HS2005	Universal human values	3			3	40	60				100
MC	MLC3002	Constitution of India #	2			No Credit						Passs/ Fail
PC	PC3101	Basic Concept of Mechatronics Lab			2	1					50	50
PC	PC3102	Strength of Materials Lab			2	1			50			50
PC	PC3103	Electrical Machines Lab			2	1			25			25
PC	PC3104	Programming in Python Lab			2	1				25		25
PR	PR3101	Entrepreneurship Programme				1					50	50
		Total	18	1	8	22	200	300	75	25	100	700

COURSE STRUCTURE and SYLLABUS- 2021 PATTERN

SECOND YEAR B. TECH., SEM-II

(w.e.f. June 2020)

Board of Studies in Mechatronics Engineering, June 2021

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SEMESTER-IV

B.Tech. Programme in Mechatronics Engineering													Programme Code: MK
Second year: Semester-IV (Curriculum:2021-2022)													
Cat	**Abbriv.**	**Course Title**	**Teaching scheme/week**			**Credits**	**Examination scheme**						
			L	**T**	**P**		**Theory**		**Theory**			**Total**
							CIA	**ESE**	**OR**	**PR**	**TW**	
PC	**PC4005**	**Theory of Machines**	**3**			**3**	**40**	**60**				**100**
PC	**PC4006**	**Microcontroller And Embedded C Programming**	**3**			**3**	**40**	**60**				**100**
PC	**PC4007**	**Microprocessors And System Programming**	**3**			**3**	**40**	**60**				**100**
PC	**PC4008**	**Sensors And Instrumentation**	**4**			**4**	**40**	**60**				**100**
BS	**BS4005**	**Mathematics- III**	**3**	**1**		**4**	**40**	**60**				**100**
MC	**MC4003**	**Innovations #**	**2**			**No Credit**						**Pass/ Fail**
PC	**PC4105**	**Theory of Machines Lab**			**2**	**1**			**50**			**50**
PC	**PC4106**	**Microcontroller And Embedded C Programming Lab**			**2**	**1**				**25**		**25**
PC	**PC4107**	**Microprocessors And System Programming Lab**			**2**	**1**				**25**		**25**
PC	**PC4108**	**Sensors And Instrumentation Lab**			**2**	**1**					**50**	**50**
PR	**PR4102**	**CAPSTON Project**			**2**	**1**					**50**	**50**
		Total	**18**	**1**	**10**	**22**	**200**	**300**	**50**	**50**	**100**	**700**

COURSE STRUCTURE and SYLLABUS- 2021 PATTERN

THIRD YEAR B. TECH., SEM-I

(w.e.f. June 2020)

Board of Studies in Mechatronics Engineering, June 2021

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SEMESTER-V

B.Tech. Programme in Mechatronics Engineering													Programme Code: MK
Third Year: Semester-V (Curriculum:2022-2023)													
Cat	**Abbriv.**	**Course Title**	**Teaching scheme/ Week**			**Credits**	**Examination scheme**						
			L	**T**	**P**		**Theory**		**Theory**			**Total**
							CIA	**ESE**	**OR**	**PR**	**TW**	
PC	**PC5010**	**Digital Signal Processing**	**3**			**3**	**40**	**60**				**100**
PC	**PC5011**	**Industrial Automation**	**4**			**4**	**40**	**60**				**100**
PC	**PC5012**	**Design of Machine Elements**	**3**			**3**	**40**	**60**				**100**
PC	**PC5013**	**Fluid Mechanics**	**3**			**3**	**40**	**60**				**100**
PC	**PC5014**	**Programming in JAVA**	**2**			**2**	**20**	**30**				**50**
HSMC	**HS5004**	**Industrial Management**	**2**			**2**	**20**	**30**				**50**
MC	**MC5004**	**Solid modelling #**	**2**			**No Credit**						**Pass/ Fail**
PC	**PC5110**	**Digital Signal Processing Lab**			**2**	**1**			**25**			**25**
PC	**PC5111**	**Industrial Automation Lab**			**2**	**1**			**50**			**50**
PC	**PC5113**	**Fluid Mechanics Lab**			**2**	**1**					**50**	**50**
PC	**PC5114**	**Programming in JAVA Lab**			**2**	**1**				**25**		**25**
PR	**PR5103**	**IPR & Patents**				**1**					**50**	**50**
		Total	**19**	**0**	**8**	**22**	**200**	**300**	**75**	**25**	**100**	**700**

COURSE STRUCTURE and SYLLABUS- 2021 PATTERN

THIRD YEAR B. TECH., SEM-II

(w.e.f. June 2020)

Board of Studies in Mechatronics Engineering, June 2021

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SEMESTER-VI

B.Tech. Programme in Mechatronics Engineering								Programme Code: MK					
Third year: Semester-VI (Curriculum:2022-2023)													
Cat	**Abbriv.**	**Course Title**	**Teaching scheme/ Week**			**Credits**	**Examination scheme**					
			L	**T**	**P**		**Theory**		**Theory**			**Total**
							CIA	**ESE**	**OR**	**PR**	**TW**	
PC	**PC6015**	**Thermodynamics & Heat Transfer**	**3**			**3**	**40**	**60**				**100**
PC	**PC6016**	**Computer Network & Cyber Security**	**3**			**3**	**40**	**60**				**100**
PC	**PC6017**	**Control Engineering**	**3**			**3**	**40**	**60**				**100**
PC	**PC6018**	**Manufacturing Technologies**	**4**			**4**	**40**	**60**				**100**
PE	**PE600***	**Professional Elective I**	**3**			**3**	**40**	**60**				**100**
MC	**MC6005**	**Finite element analysis #**	**2**			**No Credit**						**Pass/ Fail**
PC	**PC6115**	**Thermodynamics & Heat Transfer Lab**			**2**	**1**			**25**			**25**
PC	**PC6117**	**Control Engineering Lab**			**2**	**1**			**25**			**25**
PC	**PC6118**	**Manufacturing Technologies Lab**			**4**	**2**					**50**	**50**
PC	**PE610***	**Professional Elective I Lab**			**2**	**1**					**50**	**50**
PR	**PR6105**	**Mini Project based on Programming Skills**			**2**	**1**			**50**			**50**
		Total	**18**	**0**	**12**	**22**	**200**	**300**	**100**	**0**	**100**	**700**

Professional Elective – I	
PE6001	**Industry 4.0**
PE6002	**Automotive mechatronics**
PE6003	**Total quality management**

Honors Courses – Industry 4.0 & Automotive Mechatronics

Honors Courses	
HN5001	**Cyber Physical System**
HN6002	**Database Management System**
HN5011	**Automotive Machines and Drives**
HN6012	**Automotive Control Systems**

COURSE STRUCTURE and SYLLABUS- 2021 PATTERN

FINAL YEAR B. TECH., SEM-I

(w.e.f. June 2020)

Board of Studies in Mechatronics Engineering, June 2021

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SEMESTER-VII

B.Tech. Programme in Mechatronics Engineering													Programme Code: MK
Final year: Semester-VII (Curriculum:2021-2022)													
Cat	**Abbriv.**	**Course Title**	**Teaching scheme/ Week**			**Credits**	**Examination scheme**					
			L	**T**	**P**		**Theory**		**Theory**			**Total**
							CIA	**ESE**	**OR**	**PR**	**TW**	
PC	**PC7019**	**Robotics**	**4**			**4**	**40**	**60**		**-**	**-**	**100**
PC	**PC7020**	**Mechatronics System Design**	**4**			**4**	**40**	**60**				**100**
PC	**PC7021**	**CAD/ CAM**	**3**			**3**	**40**	**60**				**100**
PE	**PE700***	**Professional Elective II**	**3**			**3**	**40**	**60**				**100**
PC	**PC7119**	**Robotics Lab**			**2**	**1**			**25**			**50**
PC	**PC7120**	**Mechatronics System Design Lab**			**2**	**1**			**25**			**25**
PC	**PC7121**	**Computer Aided Manufacturing Lab**			**2**	**1**			**25**			**25**
PE	**PE710***	**Professional Elective II Lab**			**2**	**1**					**25**	**25**
PR	**PR7106**	**Project Work I**			**6**	**3**			**50**		**100**	**150**
MC	**MC7007**	**Mandatory Learning course (Financially Smart)**	**1**			**No Credit**						
		Total	**14**	**0**	**14**	**21**	**160**	**240**	**125**	**0**	**125**	**650**

Professional Electives

Professional Elective – I		
1	**PE6001**	**Industry 4.0**
2	**PE6002**	**Automotive mechatronics**
3	**PE6003**	**Total quality management**

Professional Elective – II		
1	**PE7004**	**Drone technology**
2	**PE7005**	**Additive Manufacturing**
3	**PE7006**	**Machine Learning**

FINAL YEAR B. TECH., SEM-II

(w.e.f. June 2020)

Board of Studies in Mechatronics Engineering, June 2021

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SEMESTER-VIII

B.Tech. Programme in Mechatronics Engineering								Programme Code: MK					
Final year: Semester-VIII (Curriculum:2021-2022)													
Cat	**Abbriv.**	**Course Title**	**Teaching scheme/ Week**			**Credits**	**Examination scheme**					
			L	**T**	**P**		**Theory**		**Practical**			**Total**
							CIA	**ESE**	**OR**	**PR**	**TW**	
OE	**OE800***	**Open Elective I**	**3**			**3**	**40**	**60**	**-**			**100**
OE	**OE800***	**Open Elective II**	**3**			**3**	**40**	**60**	**-**			**100**
PR	**PR8107**	**Project Work II**			**4**	**2**			**50**			**50**
PR	**PR8108**	**Professional Internship**			**8**	**6**			**50**		**100**	**150**
MC	**MC8008**	**Mandatory Learning course**	**1**			**No Credit**						**Pass/ Fail**
		Total	**6**	**0**	**12**	**14**	**80**	**120**	**100**	**0**	**100**	**400**

Honor Courses

(w.e.f. June 2020)

Board of Studies in Mechatronics Engineering, June 2021

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HN	Honors Courses		

Honors Courses – Industry 4.0

B.Tech. Programme in Mechatronics Engineering													**Programme Code: MK**
Honors Course: Industry 4.0 (Curriculum 2021-22)													
SEM	**Abbriv.**	**Course Title**	**Teaching scheme/ Week**			**Credits**	**Examination scheme**						
			L	**T**	**P**		**Theory**		**Theory**			**Total**	
							CIA	**ESE**	**OR**	**PR**	**TW**		
V	**HN5001**	**Cyber Physical Systems**	**4**			**4**	**40**	**60**				**100**	
VI	**HN6002**	**DBMS & Information security in Automation**	**4**			**4**	**40**	**60**				**100**	
VI	**HN6102**	**DBMS & Information security in Automation Lab**			**2**	**1**					**50**	**50**	
VI	**HN7003**	**Industrial IoT & Internet of Services**	**4**			**4**	**40**	**60**				**100**	
VII	**HN7103**	**Industrial IoT & Internet of Services Lab**			**2**	**1**					**50**	**50**	
VIII	**HN8004**	**Cyber Security in Manufacturing**	**4**			**4**	**40**	**60**				**100**	
		Total	**16**	**0**	**4**	**18**	**160**	**240**	**0**		**100**	**500**	

Honors Courses –Automotive Mechatronics

B.Tech. Programme in Mechatronics Engineering													**Programme Code: MK**
Honors: Automotive Mechatronics (Curriculum 2021-22)													
SEM	**Abbriv.**	**Course Title**	**Teaching scheme/ Week**			**Credits**	**Examination scheme**						
			L	**T**	**P**		**Theory**		**Theory**			**Total**	
							CIA	**ESE**	**OR**	**PR**	**TW**		
V	**HN5011**	**Automotive Machines & Dives**	**4**			**4**	**40**	**60**				**100**	
V	**HN5111**	**Automotive Machines & Drives Lab**			**2**	**1**					**50**	**50**	
VI	**HN6012**	**Automotive Control systems**	**4**			**4**	**40**	**60**				**100**	
VI	**HN7013**	**Introduction to Battery Management System**	**4**			**4**	**40**	**60**				**100**	
VII	**HN7113**	**Introduction to Battery Management System Lab**			**2**	**1**					**50**	**50**	
VIII	**HN8014**	**Electric Vehicles and Mobility**	**4**			**4**	**40**	**60**				**100**	
		Total	**16**	**0**	**4**	**18**	**160**	**200**			**100**	**500**	

PC: (PC3001): BASIC CONCEPTS OF MECHATRONICS

Teaching Scheme	Examination Scheme
Lectures: 04 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 04	**Total Marks: 100 Marks**

Prerequisite Course: Basic Physics, Engineering Mechanics, Basic Electricals & Electronics, Computer fundamentals & Programming

Competency: **Understanding the Basic concepts and key elements of mechatronic system**.

Course Objectives:

Sr. No.	Course Objectives
1	This aims at providing fundamental understanding about the concepts of a mechatronics system, interfacing, and analysis.
2	To understand the basic elements of mechatronic system
3	Analyze and Apply Operational Amplifier circuits, A/D and D/A converters and their applications.
4	Illustrate and Analyze Combinational Logic circuits, Simplification of Algebraic Equations using Karnaugh Maps
5	Design and Analyze Decoders, Encoders, Digital multiplexers, Adders and Subtractors, Binary comparators, Latches and Master-Slave Flip-Flops

Course Outcomes (COs): At the end of this course, students will be able to:

CO. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To understand and apply the basic concept of Mechatronic system in integration and control with Mechanical and Electronic system approach.	3	**Apply**
2	To Identify and use different types of basic elements of mechatronic system	2	**Understand**
3	To Apply and Execute the knowledge of Op-Amp and its applications in different industrial Applications.	3	**Apply**
4	To Design different logic circuit using basic gates and apply it on various Digital Applications.	3	**Apply**
5	To Understand different concepts of Flip Flops and Registers and Implementation in various Applications.	3	**Apply**
6	Demonstrate some system modifications to incorporate them into mechatronic system.	4	**Analyse**
7	Apply the ethics of academic integrity in project based activity.	3	**Apply**

Mapping of COs to POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	1	0	1	3	0	3	0	1	3	0	0
CO2	1	2	2	1	1	0	0	3	3	3	0	1	2	0	0
CO3	1	1	2	1	0	0	1	3	3	3	0	1	2	0	0
CO4	1	1	2	1	2	0	1	3	3	3	0	1	2	0	0
CO5	1	1	2	1	2	0	1	3	3	3	0	1	2	0	0
CO6	2	3	2	1	3	2	2	3	3	3	0	3	3	1	3
CO7	3	1	3	3	3	2	3	3	3	3	2	3	3	1	3

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Introduction to Concepts of Mechatronics** Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Transfer function approach, Integrated Product Design, Modelling, Analysis Man-Machine Interface. Micro mechatronic systems (MEMS): Microsensors, Micro actuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc.	06	1
II	**Basic elements of Mechatronics system** Sensor's transducers and actuators: classification, Development in Transducer technology, Concepts of controllers, Opto- Electronics-Shaft encoders, Vision System, etc. Electrical Actuators such as servo motor and Stepper motor, Drive circuits. Graphical Display: LED, LCD, OLED, PDP, Touch screen.	08	2
III	**OPAMP** Introduction to Operational Amplifier: Ideal v/s practical Op Amp, Performance Parameters, Operational Amplifier Application Circuits: Peak Detector Circuit, Comparator, Differentiator, Integrator, Relaxation Oscillator, Current-To-Voltage Converter, Voltage-To Current Converter. Introduction to A/D and D/A converter, Characteristics of A/D and D/A converter, Application with OP Amp	06	3
IV	**Digital Electronics** The Basic Gates: Review of Basic Logic gates, Positive and Negative Logic, Introduction to HDL. Combinational Logic Circuits: Sum-of-Products Method, Truth Table to Karnaugh Map, Pairs Quads, and Octets, Karnaugh Simplifications, Don't-care Conditions, Product-of-sums Method, Product-of-sums simplifications, MUX, DEMUX, Decoders, Encoders	06	4
V	**Flip-Flops and Registers** Flip- Flops: FLIP-FLOP Timing, JK Master-slave FLIP-FLOP, Switch Contact Bounce Circuits, Various Representation of FLIP-FLOPs, HDL Implementation of FLIP-FLOP. Registers: Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In -Serial Out, Parallel In - Parallel Out, Universal Shift Register,	06	5

	Applications of Shift Registers		

Textbooks:

1. Devdas Shetty & Richard A. Kolk, Mechatronics: A Multidisciplinary Approach, PWS Publishing Company
2. A.S. Sedra & K.C.Smith, Microelectronics Circuits, 1997, Oxford University Press
3. Digital Systems: Principles and Applications by Ronald J. Tocci, Neal S. Widmer, and Greg Moss.
4. Sensors and Actuators: Engineering System Instrumentation by Clarence W. de Silva

Reference Books:

1. Mechatronics: Principles and Applications" by Godfrey C. Onwubolu Published by Butterworth-Heinemann, 2005,
2. "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" by W. Bolton Published by Pearson Education Limited, 2015
3. Mechatronics: A Multidisciplinary Approach" by W. Richard Longman Published by Prentice Hall, 2001

E-Resources:

1. **Mechatronics and Manufacturing Automation**
   Dr. Shrikirshna.N.Joshi , Department of Mechanical Engineering IIT Guwahati
   https://nptel.ac.in/courses/112103174
2. **Mechatronics**
   By Prof. Pushparaj Mani Pathak, IIT Roorkee
   https://nptel.ac.in/courses/112107298

PC: (PC3101): BASIC CONCEPTS OF MECHATRONICS LAB

Teaching Scheme Practical: 02 Hrs./ Week	Examination Scheme Term work: 50 Mark
Credits: 01	Total Marks: 50 Mark

Prerequisite Course: **Fundamentals of Basic Electrical and Electronics Engineering, Basic Mechanics and Mathematics**

Sr. No.	Course Objectives
1	Develop an understanding about the basic electronics and mechanical components
2	Develop proficiency in designing circuit for analog and digital applications
3	Develop an understanding about transducers and their implementation

Course Outcomes (COs): At the end of this course, students will be able to:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Understanding of basic Electronics and Mechanical components	2	Understanding
2	Implement Analog and Digital circuits with various electronic components	3	Apply
3	Understanding Transducers	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	1	1	1	2	2	2	1	-	3	-	-
CO2	3	-	1	2	3	1	-	2	2	2	-	-	3	-	-
CO3	3	-	-	1	1	1	1	2	2	2	1	-	3	-	-

List of Experiments: Laboratory work

1. Familiarization of Resistors, Capacitors, Inductors, Diodes, Transistors and Bread Board
2. Familiarization of Gears, Gear train, Bearings, Coupling and Backlash
3. Familiarization of CRO, DSO, Transformer, Function Generator, Multimeter and Power supply
4. Design and Construct Schmitt trigger using OPAMP.
5. Design and construct rectangular wave form generator.
6. To verify the truth table of various Logic Gates
7. Design and implement Half Adder and Full Adder & Half Subtractor and Full Subtractor
8. Realize J-K Master-Slave Flip-Flop
9. To measure the characteristics of LVDT with trainer kit

VIRTUAL LAB Learning:

S. No.	Experiment Name	Experiment Link(s)
1	Circuit simulation online and study	https://www.circuitlab.com/

PC: (PC3002): STRENGTH OF MATERIALS

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week **Tutorial: 01 Hrs. / Week**	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 04	**Total Marks: 100 Marks**

Prerequisite Course: Fundamentals of Engineering Mechanics and Mathematics

Course Objectives:

Sr. No.	Course Objectives
1	Learn and understand the concepts of stresses and strains thereby strength of materials.
2	Learn and understand the SFD and BMD for various types of beams and loadings.
3	Learn and understand the concepts of bending and shear for different loadings and cross sections.
4	Learn and understand torsion mechanism for hollow and solid cross sections shafts in series and parallel.
5	Learn and understand the principal stresses, strains, and Theories of failure
6	Learn and understand to compute stresses acting in cylinders and shells.

Course Outcomes (COs): At the end of this course, students will be able to,

No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	calculate stresses and strains in engineering materials under different types of loading and analyze the behavior of these materials.	3	**Apply**
2	draw shear force and bending moment diagrams to understand the internal forces and moments acting on them.	3	**Apply**
3	calculate the slope and deflection of determinate beams under external loads and understand the effects of beam properties and loading conditions on the beam's behavior.	3	**Apply**
4	determine the torque and angle of twist, as well as the stresses and deformation in the circular, hollow, and stepped shafts under torsional loading	3	**Apply**
5	analyze mechanical structures under different loading conditions, and determine the principal stresses and strains based on theories of failure.	4	**Analyse**
6	determine the stresses and deformation in these cylinders under internal and external pressure to structures, and understand the effects of geometry, material properties, and loading conditions on their behavior.	3	**Apply**
7	Use computational tools to solve engineering problems and communicate finding through oral presentation and report writing.	3	**Apply**

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**3**	1	2	2	2	-	1	2	1	-	**3**	-	-	-
CO2	**3**	**3**	2	2	3	2	-	2	2	2	-	**2**	-	-	-
CO3	**3**	**3**	2	-	1	2	-	2	2	1	2	**1**	-	-	-
CO4	**3**	**3**	2	2	2	2	-	2	2	2	-	**1**	-	-	-
CO5	**3**	**3**	1	2	2	1	-	1	2	1	-	**1**	-	-	-
CO6	**3**	**3**	2	3	2	2	-	2	1	2	2	**1**	-	-	-
CO7	**3**	**3**	1	2	2	3	-	1	2	1	-	**3**			

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Stresses and strains:** Deformation in solids- Hooke's law, stress, and strain- tension, compression, and shear stresses- elastic constants and their relations- volumetric, linear and shear strains	08	1
II	**Analysis of Beam:** Beams and type's transverse loading on beams- shear force and bend moment diagrams- Types of beams supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.	06	2
III	**Slope and deflection of beams:** Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.	06	3
IV	**Torsion:** Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.	06	4
V	**Principal stresses and strains:** Principal stresses and strains: Normal and shear stresses on any oblique plane. Derivation of expression for principal stresses and maximum shear stresses. Graphical solution using Mohr's circle of stresses. Theories of elastic failure: Maximum principal stress theory, maximum shear stress theory, maximum distortion energy theory.	06	5
VI	**Stresses in Cylinders and Shells:** Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.	06	6

Textbooks:

1. R. Subramanian, “Strength of materials”, Oxford University Press**. ISBN: 10:0-19-567590-4**
2. A.K. Datta, D Gosh “Strength of materials”, New Age International Publications. **ISBN:978-81-224-3080-6**
3. S. S. Ratan, “Strength of Materials”, Tata McGraw Hill Publication **ISBN:978-066895-9**
4. S.S. Bhavikatti, “Strength of Materials”, Vikas Publishing House Pvt. Ltd. 4th Edition. **ISBN:**9789325971578
5. B.C. Punmia, Ashoak kumar Jain, Arun Kumar Jain. “Mechanics of Materials, Laxmi Publication Pvt. Ltd. **ISBN:978-81-318-0646-3**

Reference Books:

1. Ferdinand P. Beer, E. Russell Johnston Jr., John T. Dewolf, david F.Mazurek. “Mechanics of Materials.5th Edition, Tata McGraw Hill Education Pvt.Ltd. New Delhi. **ISBN10:0-07-015389-2**
2. E.P. Popov, “Introduction to Mechanics of Solids, Prantice Hall Publication. **ISBN:978-0134877693**
3. Gere and Timoshenko, “Mechanics of materials, CBS Publication.**ISBN:978-8123908946**
4. S. Timoshanku Strength of material (Third edition**)** CBS Publication
5. Stephen H Crandall, Norman C. Dahi, Thomas J Lardner “An introduction to the mechanics of Solids” Tata McGraw Hill
6. S. Ramamrutham, R. Narayanan “Strength of Materials”, Dhanpat Rai Publication Company.ISBN:9788187433545.,9788187433545.

E-Resources:

- Strength of Materials: Mechanical Engineering by Dr. Satish C Sharma (IIT Roorkee) https://nptel.ac.in/courses/105/105/105105108/
- Video content: Strength of Materials: Prof. S.K. Bhattacharyya (IIT Kharagpur)
- Coursera: Course offered by Georgia Institute of Technology Mechanics of Materials I: Fundamentals of Stress, Strain and Axial Loading https://www.coursera.org/learn/mechanics-1
- Georgia Institute of Technology-Online Course_ https: //www.coursera.org/lecture/materials-structures/module21-solve-a-combined static-loading-problem-9bvsj
- http://solidmechanics.org/index.html
- Mechanics of Materials: https://ocw.mit.edu/courses/materials-science-and-engineering/3-11-mechanics-of-materials-fall-1999/modules/#java

PC: (PC3102): STRENGTH OF MATERIALS LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Oral Exam: 50 Mark**
Credits: 01	**Total Marks: 50 Mark**

Prerequisite Course: Fundamentals of Engineering Mechanics and Mathematics

Sr. No.	Course Objectives
1	Students will know the various material testing methods.
2	Students will know use of advanced engineering tools for better understanding of strength of materials.
3	Students will be able to identify types of stresses on different mechanical components with principal stresses and theories of failures.

Course Outcomes (COs): At the end of this course, students will be able to,

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	perform tension, compression, shear, bending and torsion test of different engineering components.	3	Apply
2	draw shear force and bending moment diagrams for determinate beams due to external loads.	3	Apply
3	use of advanced engineering tools for better understanding of strength of materials.	3	Apply
4	to calculate stresses and deformation in cylinders and shells.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	---	1	1	2	1	---	2	2	2	---	---	---	---	---
CO2	3	---	1	1	2	1	---	2	2	2	---	---	---	---	---
CO3	3	---	1	1	2	1	---	2	2	2	---	---	---	---	---
CO4	3	---	1	1	2	1	---	2	2	2	---	---	---	---	---

List of Experiments: Laboratory work

1. Tension test on a ductile and brittle material
2. Compression test on any material (Virtual Lab)
3. Shear test (single and double) on a ductile material
4. Bending test on ductile material for simply supported beam.
5. Plotting of shear force and bending moment diagrams for different boundary conditions and loading conditions of beam (using software)
6. Comparison of numerical and analytical analysis on Slope and deflection (by using software)
7. Torsion Test on Solid Circular Mild Steel Shaft (Virtual Lab)
8. Determination of Principal stresses by graphical method and verification through analytical method

9. Calculate Axial and hoop stresses in cylinders subjected to internal pressure by Python programming

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

Sr. No.	Experiment Name	Experiment Link(s)
1	Tension test on a ductile and brittle material	http://rtlabs.nitk.ac.in/?q=page/strength-materials-lab
2	Compression test on any material (Virtual Lab)	https://sm-nitk.vlabs.ac.in/#
3	Shear test (single and double) on a ductile material	https://sm-nitk.vlabs.ac.in/#
4	Bending test on ductile material for simply supported beam.	http://rtlabs.nitk.ac.in/?q=page/strength-materials-lab

PC: (PC3003): ELECTRICAL MACHINES

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits : 03	**Total Marks: 100**

Prerequisite Course :

1. Basic Electrical Engineering.
2. Basic circuital Laws.

Course Objectives:

Sr. No.	Course Objectives
1	To study performance characteristics of a D.C. Shunt motor.
2	To study speed control of dc shunt motors by varying armature circuit and field circuit method.
3	To understand an open circuit test and block rotor test on a 3 phase IM to draw an equivalent circuit.
4	To determine the performance characteristics of a three-phase induction motor.
5	To determine performance parameters on universal motor DC and AC supply voltage.

Course Outcomes (COs): At the end of this course, students will be able to, :

CO.No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	To summarize building blocks and working principle of DC machines	**2**	**Understand**
CO2	To interpret the concept of rotating magnetic field with varying field excitations for DC motoring and generation principle	**2**	**Understand**
CO3	To summarize construction, working principle and starting mechanism of AC induction machines.	**2**	**Understand**
CO4	To describe performance characteristics and starting methods of single phase induction motor	**3**	**Apply**
CO5	To integrate operating characteristics curves and regulation of synchronous machine with phasor diagrams and power angle.	**3**	**Analyze**
CO6	Understand the real life applications of Electric Machine.	**2**	**Understand**
CO7	Communicate with engineers and the community at large in written an oral forms.	**3**	**Apply**

Mapping of COs to POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	2	1	-	-	-	-	-	-	-	-	1	3	2	-
CO 2	1	2	2	-	-	-	-	-	-	-	-	2	2	1	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	1	2	1	-
CO 4	3	1	-	-	-	-	-	-	-	-	-	2	1	2	-
CO 5	3	1	2	-	-	-	-	-	-	-	-	1	2	1	-

CO 6	3	-	3	1	3	-	-	-	-	-	-	3	3	-	-
CO7	2	-	2	2	-	-	-	-	2	2	-	3	3	-	-

Course Contents

Unit No	Unit Title	No.of Hours	COs
I	**DC Machines-I** Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction	08	1
II	**DC Machines –II:** Motoring and generation Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines..	08	2
III	**Induction Machines** Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.	08	3
IV	**Single-phase induction motors** Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications.	08	4
V	**Synchronous machines** Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.	08	5

Text Books:

1. A. E. Fitzgerald and C. Kingsley, “Electric Machinery”, McGraw Hill Education, 2013.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.

3. P. S. Bhimbhra, “Electrical Machines”, Khanna Book Publishing House, 2018.
4. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.

Reference Books:

1. H Cotton, ‘Elements of Electrical Technology’ C.B.S. Publication, 2005, ISBN : 978-8123909288
2. B. L. Theraja, ‘Text book of Electrical technology Vol.1 and Vol. 2’, , S. Chand and Company Ltd, ISBN: 978-8121924405
3. D. C. Kulshreshtha, ‘Basic Electrical Engineering.’, Tata McGraw Hill, 2009, ISBN:978-0071328968
4. Edward Hughes, ‘Electrical Technology. ’ Pearson Edition , 2010, ISBN:978-0582226968
5. A. S. Langsdorf, “Alternating current Machines”, McGraw Hill Education, 1984.
6. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007.
7. P. S. Bhimbhra, “Power Electronics”, Khanna Publishers, 2017

E-Resources:

i. NPTEL course on Electrical machines *https://nptel.ac.in/courses/108/105/108105155/*
ii. Coursera Motors and Motor Control Circuits *https://www.coursera.org/learn/motors-circuits-design*

PC: (PC3103): ELECTRIC MACHINES LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Oral Exam: 25 Marks**
Credits: 01	**Total Marks: 25 Marks**

Prerequisite Course: 1. Basic Electrical Engineering , 2. Basic circuital Laws.

Course Outcomes (COs): At the end of this course, students will be able to,

CO' No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	Interpret and follow the safety precautions to be taken while performing the practical	**2**	**Understand**
CO2	Analyze the performance parameters, speed control and load test of DC machines	**4**	**Analyze**
CO3	Determine the performance characteristics, speed control of a three-phase induction motor by performing various tests on it.	**2**	**Understand**
CO4	Analyze the differences in operation of universal motor for dc and ac configurations by performing load test.	**4**	**Analyze**
CO5	Select a proper electrical machine used in projects for specific mechatronics application	**3**	**Apply**

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	2	1	-	-	-	-	-	-	-	-	1	3	2	-
CO 2	1	2	2	-	-	-	-	-	-	-	-	2	2	1	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	1	2	1	-
CO 4	3	1	-	-	-	-	-	-	-	-	-	2	1	2	-
CO 5	3	1	2	-	-	-	-	-	-	-	-	1	2	1	-

List of Experiments: Laboratory work

1. Performance characteristics of a D.C. Shunt motor.
2. Speed control of dc shunt motor by varying armature circuit and field circuit method.
3. Load test of D.C. shunt motor.
4. Perform an open circuit test and block rotor test on a 3 phase IM to draw equivalent circuit.
5. Perform load test on a universal motor and determine the performance with dc/ac supply voltage.
6. Speed control of 3 phase Induction Motor.
7. Determination of the performance characteristics of a three-phase induction motor by load test.
8. Obtain a circle diagram of the given three-phase induction motor by conducting no load and blocked motor test and to determine the maximum torque, maximum power output.

PC: (PC3004): PROGRAMMING IN PYTHON

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100 Marks**

Prerequisite Course: Fundamentals of Programming.

Course Objectives:

Sr. No.	Course Objectives
1	To explain basic principles of Python programming language.
2	To understand the concepts of variables and loops.
3	To apply concepts of Functions.
4	To Explain the Lists, Tuples, Dictionaries etc.
5	Apply python programming knowledge to build database oriented applications.
6	Apply python programming to visualize results of the applications for better understanding.

Course Outcomes (COs): At the end of this course, students will be able to,

CO.No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	**Explain** basic principles of Python programming language.	1	Remember
2	**Understand** the variables, statements, and loops.	2	Understand
3	**Create** the Files and Classes.	5	Create
4	**Understand** the concept of data structure and algorithm.	2	Understand
5	**Apply** concept of CGI and Database	3	Apply
6	Develop application using python code database.	6	Design

Mapping of COs to POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	2	-	2	-	-	-	-	-	-	1	-	-	--
CO2	-	-	2	-	2	-	-	-	-	-	-	1	-	-	--
CO3	-	-	3	-	2	-	-	-	-	-	-	1	-	-	---
CO4	-	-	3	-	2	-	-	-	-	-	-	1	-	-	--
CO5	-	-	3	-	2	-	-	-	-	-	-	1	-	-	--

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**INTRODUCTION TO PYTHON PROGRAMMING** Installation of python IDLE, Basic Syntax, First Python Program, Identifiers, Reserve words, Comments, Variables and Data types.	08	1
II	**VARIABLE, LOOPS AND STATEMENT** Variables, While Loops, For Loops, If Statements, If Else Statements, Else and elif Statements, Break, Continue and Pass.	08	2
III	**FILE HANDLING, CLASSES AND OOPS CONCEPTS** Introduction, Python file handling- Create, Open, Append, Read, and Write, Classes, Classes in Python, Principles of Object Orientation, Creating Classes, Inheritance, Polymorphism, Creating Instance Objects.	08	3
IV	**ALGORITHM AND DATA STRUCTURE** Stack, Queue, Tree, ordered list, Introduction to Recursion, Divide and Conquer Strategy, Greedy Strategy, Graph Algorithms. theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.	08	4
V	**CGI AND DATABASE ACCESS** **CGI-**What is CGI? Web Browsing, CGI Architecture, Web Server Support and Configuration, First CGI Program, GET and POST Methods. **Database-** What is MySQLdb? How do I Install MySQLdb? Database Connection, Creating Database Table, Operation- Insert, update, delete, Perform Commit and Rollback.	08	5

Textbooks:

1. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016.
2. Learn Python the Hard Way, Zed A. Shaw (3rd Edition)
3. Kenneth A Lambert and B L Juneja, “Fundamentals of PYTHON”, CENGAGE Learning, ISBN:978-81-315-2903-4

Reference Books:

1. MarksLutz, Programming Python, O`Reilly, 4th Edition, 2010
2. R2. Allen B Downey, “Think PYTHON”, O’Rielly, ISBN: 13:978-93-5023-863-9, 4th Indian Reprint 2015.

PC: (PC3104): PROGRAMMING IN PYTHON LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Practical Exam: 25 Mark**
Credits: 01	**Total Marks: 25 Mark**

Prerequisite Course: Fundamentals of Programming.

Course Outcomes (COs): At the end of this course, students will be able to,

Sr. No.	Course Objectives
1	Students will know the basics of python programming.
2	Students will be able to implement core python programs.
3	Students will know the communication of front-end with back-end.

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	2	-	2	-	-	-	-	-	-	1	-	-	--
CO2	-	-	2	-	2	-	-	-	-	-	-	1	-	-	--
CO3	-	-	3	-	2	-	-	-	-	-	-	1	-	-	---
CO4	-	-	3	-	2	-	-	-	-	-	-	1	-	-	--
CO5	-	-	3	-	2	-	-	-	-	-	-	1	-	-	--

List of Experiments: Laboratory work

1. Write python program to print Hello World and Hello World using string variable.
2. Write python program to store data in list and then try to print them.
3. Write python program to do basic trim and slice on string.
4. Write python program to print list of numbers using range and for loop.
5. Write python program to let user enter some data in string and then verify data and print welcome to user.
6. Implement a Python program to Calculate the most frequent words in a text read from a file.
7. Write a python program to design web GUI.
8. Write a python program to connect database and perform various operations like- Insert, Update, Delete, etc.

HSMC: (HS205): UNIVERSAL HUMAN VALUES

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100 Marks**

Prerequisite Course: Nil

Course Objectives:

Sr. No.	Course Objectives
1	To make the students aware about the concept and need of value education.
2	To help the students appreciate the essential complementarity between values and skills to ensure sustained happiness and prosperity
3	To facilitate the development of a holistic perspective among the students towards life and profession.
4	To facilitate the understanding of harmony at various levels staring from self and going towards family, society, and nature.
5	To make the students aware about the correlation between engineering ethics and social experimentation in various situations.
6	To highlight the importance of professional ethics in the wake of global realities.

Course Outcomes (COs): At the end of the course student will be able to:

COs No.	Course Outcomes (COs)	Bloom's Taxonomy	
		Level	Descriptor
1	Recognize the concept of self-exploration as the process of value education.	1	Remember
2	Interpret the human being as the coexistence of self and body.	2	Understand
3	Apply the holistic approach for fulfilling human aspirations for the humans to live in harmony at various levels.	3	Apply
4	Organize the universal human order in correlation with professional ethics.	4	Analyze
5	Implement ethical practices in engineering profession.	3	Apply
6	Outline the importance of various ethical practices in the wake of global realities.	4	Analyze

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	-	3	-	1	-	2	-	3
CO2	-	-	-	-	-	2	-	3	-	1	-	2	-	3
CO3	-	-	-	-	-	3	2	3	-	1	-	2	-	3
CO4	-	-	-	-	-	3	-	3	-	1	-	2	-	3
CO5	-	-	-	-	-	3	-	3	-	1	-	2	-	3
CO6	-	-	-	-	-	3	2	3	-	1	-	2	-	3

Course Contents

Unit No	Unit Title	No. of Hrs	COs
I	**Introduction to Value Education:** Values, Morals and Ethics; Concept and need of value education; Self-exploration as the process for value education; Guidelines for value education; Basic human aspirations and their fulfillment	06	1
II	**Harmony in Human Being** : Human being as the coexistence of self and the body; Discrimination between the needs of the self and the body; The body as an instrument; Harmony in the self; Harmony of the self with the body	06.	2
III	**Harmony in the family, Society and Nature:** Harmony in the family- The basic unit of human interaction; Values in the human to human relationship; Harmony in the society; Vision for the universal human order; Harmony in the nature; Realizing existence as coexistence at all levels	06	3
IV	**Professional Ethics** : Natural acceptance of human values; Definitiveness of ethical human conduct; Humanistic education and universal human order; Competence in professional ethics; Transition towards value-based life and profession	06	4
V	**Engineering Ethics and Social Experimentation** : Need of engineering ethics; Senses of engineering ethics; Variety of moral issues; Moral autonomy; Utilitarianism; Engineering as experimentation; Engineers as responsible experimenters; Codes of ethics	06	5
VI	**Global Issues**: Globalization and multi-national corporations; Cross-cultural issues; Business ethics; Environmental ethics; Computer ethics; Bioethics; Ethics in research; Intellectual property rights and plagiarism	06	6

Textbooks:

1. R. R. Gaur, R. Sangal, G. P. Bagaria, “A Foundation Course in Human Values and Professional Ethics”, Excel Books Pvt. Ltd.
2. R. S. Naagarazan, “A Textbook on Professional Ethics and Human Values”, New Age International (P) Ltd. Publishers

Reference Books

1. B. P. Banerjee, “Foundations of Ethics and Management”, Excel Books Pvt. Ltd.
2. P. L. Dhar, R. R. Gaur, “Science and Humanism”, Commonwealth Publishers
3. M. K. Gandhi, “The Story of my Experiments with Truth”, Discovery Publisher
4. http://uhv.org.in/

MLC: (MC3002): CONSTITUTION OF INDIA

Teaching Scheme: Lectures: 02 Hrs. / Week	Evaluation Scheme: Audit Course- No credits

Course Objectives:

Sr. No	Course Objectives
1	To study the historical background, salient features, and preamble of Indian constitution
2	To study the provision of fundamental right in the Indian constitution.
3	To study the directive principle of state policy and fundamental duties.
4	To study the system of government through parliamentary and federal system.
5	To understand the formation, structure, and legislative framework of central government.
6	To understand the formation, structure, and legislative framework of state government.

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

COs No	Course Outcomes	Blooms Taxonomy	
		Level	Descriptor
CO1	Explain historical background, salient features, and preamble of Indian constitution	2	Understand
CO2	Understand about their obligations, responsibilities, privileges, and fundamental rights	2	Understand
CO3	Explain directive principle of state policy and fundamental duties.	2	Understand
CO4	Understand the system of government through parliamentary and federal system.	2	Understand
CO5	Understand formation, administrative and judicial set up of central government.	2	Understand
CO6	Understand the formation, administrative and judicial set up of state government.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	--	--	--	--	--	3	-	2	--	---	--	--	--	--
CO2	--	--	--	--	--	3	-	2	--	---	--	--	--	--
CO3	--	--	--	--	--	3	-	2	--	--	--	--	--	--
CO4	--	--	--	--	--	3	-	2	--	--	--	--	--	--
CO5	--	--	--	--	--	3	-	2	--	--	--	--	--	--
CO6	--	--	--	--	--	3	-	2	--	--	--	--	--	--

COURSE CONTENTS

Unit No.	Unit Title	No. of Hrs.	COs
I	**Introduction to Constitution of India** a. Historical background b. Salient features c. Preamble of constitution	07	1
II	**Fundamental rights** a. Features of fundamental rights b. Basic rights 1. Right to equality; 2. Right to freedom; 3. Right against exploitation; 4. Right to freedom of religion; 5. Cultural and educational rights; 6. Right to property; 7. Right to constitutional remedies	05	2
III	**(A) Directive principle of state policy:** a. Features of directive principle b. Classification of directive principle c. Criticism of directive principle d. Utility of directive principle e. Conflict between Fundamental rights and directive principle **(B) Fundamental duties:** a. List of fundamental duties b. Features of fundamental duties c. Criticism of fundamental duties d. Significance of fundamental duties e. Swaran Singh Committee Recommendations	05	3
IV	**System of Government** a. Parliamentary system: Features of parliamentary government, Features of presidential government, merits, and demerit of Parliamentary system b. Federal system: Federal features of constitution, unitary features of constitution c. Centre and state relation: Legislative relation, administrative relations, and financial relations. d. Emergency provision: National emergency, financial emergency, and criticism of emergency provision	05	4
V	**Central government** a. President: Election of president, powers and functions of president, and Veto power of president b. Vice-president: Election of vice-president, powers, and functions of vice-president c. Prime minister: Appointment of PM, powers and functions of PM, relationship with president d. Central council of ministers: Appointment of ministers, responsibility of ministers, features of cabinet committees, functions of cabinet committees. e. Parliament: Organization of parliament, composition of the two houses , duration two houses, membership of parliament, session of parliament, joint sitting of two houses, budget in parliament. f. Supreme court (SC): Organization of supreme court, independence of supreme court, jurisdiction, and powers of supreme court .	05	5

VI	**State government** a. Governor: Appointment of governor, powers and functions of governor, constitutional position b. Chief minister: Appointment of CM, powers and functions of CM, relationship with governor c. State council of ministers: Appointment of ministers, responsibility of ministers, cabinet. d. High court (HC): Organization of HC, independence of HC, jurisdiction and powers of HC e. Sub-ordinate court: Structure and jurisdiction, Lok Adalats, Family court, Gram Nyayalayas	05	6

Reference Books

1. Indian Polity for Civil Service Examination, M Laxmikanth, Mc GrawHill Education, Fifth Edition.
2. Introduction to the Constitution of India, Durga Das Basu, LexisNexis, 22nd Edition

PR: (PR3101): ENTREPRENEURSHIP PROGRAMME

Teaching Scheme	Examination Scheme
Practical: 2 Hrs. / Week	**Term work : 50 Marks**
Credits: 01	**Total Marks: 50 Marks**

Course Objectives:

Sr. No	Course Objectives
1	To provide fundamental understanding about the basics of Entrepreneurship
2	To acquire entrepreneurial spirit and resourcefulness
3	To familiarize students with various uses of human resource for earning dignified means of living
4	To understand the concept and process of entrepreneurship - its contribution and role in the growth and development of individual and the nation
5	To acquire entrepreneurial quality, competency, and motivation
6	To learn the process and skills of creation and management of entrepreneurial venture

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

COs No	Course Outcomes	Blooms Taxonomy	
		Level	Descriptor
CO1	To understand the dynamic role of entrepreneurship and small businesses	2	**Understand**
CO2	To learn organizing and managing a small business	2	**Understand**
CO3	To learn Financial Planning and Control	2	**Understand**
CO4	To understand strategic marketing planning	2	**Understand**
CO5	To develop the ability to identify the problem statement	3	**Apply**
CO6	To create the business plan	3	**Apply**

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	--	--	--	--	--	3	--	2	--	3	**3**	**2**	--	--	--
CO2	--	--	--	--	--	2	3	3	--	3	**2**	**2**	--	--	--
CO3	--	--	--	--	--	2	--	3	--	3	**2**	**2**	--	--	--
CO4	--	--	--	--	--	2	3	3	--	3	**3**	**2**	--	--	--
CO5	--	--	--	--	--		--	3	**2**	3	**2**	**2**	--	--	--
CO6	--	--	--	--	--		--	3	**2**	--	**3**	**2**	--	--	--

COURSE CONTENTS

Unit No.	Unit Title	No. of Hrs.	COs
I	**Basics of Entrepreneurship,** Terminologies related to entrepreneurship, stages in starting a small scale industry, virtual tour for understanding the structure of any industry, motivation	04	1,4
II	**Case study,** Project identification- assessment of viability, formulation, evaluation, financing, field-study, and collection of information Case study about the journey of an enterprise, Basics of IPR, fundamentals of operations research	06	1,2
III	**Industrial visit,** Physical visit and report writing	06	1,6
IV	**Financing of the start-up,** Preparation of balance sheets, assessment of economic viability, expected costs, advertisement, possible ways of financing the start-up, Government policies	04	3,4
V	**Business proposal,** Scientific writing, business plan, presentation of business proposals in groups	04	6

Reference Books

S. No.	Title of Book	Author	Publication
1	Entrepreneurship	Forbat, John,	New Age International
2	Management and Entrepreneurship	Havinal, Veerbhadrappa	New Age International
3	Essential of Management	Joseph, L. Massod	Prentice Hall of India
4	The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company	Steve Blank and Bob Dorf	K & S Ranch ISBN – 978-0984999392
5	The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses	Eric Ries	Penguin UK ISBN – 978-0670921607
6	Demand: Creating What People Love Before They Know They Want It	Adrian J. Slywotzky with Karl Weber	Headline Book Publishing ISBN – 978-0755388974

-Resources:

- NPTEL Course - ENTREPRENEURSHIP ESSENTIALS BY PROF. MANOJ KUMAR MONDAL Department of Multidisciplinary IIT Kharagpur https://archive.nptel.ac.in/courses/127/105/127105007/

PC: (PC4005): THEORY OF MACHINES

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100 Marks**

Prerequisite Course: Linear Algebra and Stochastic Process, Multivariate Calculus

Course Objectives:

Sr. No	Course Objectives
1	To make students familiarize with concepts and techniques of vector calculus, probability, andrandom processes.
2	The intent is to furnish them with the techniques to understand engineering mathematics and itsapplications that would develop logical thinking power, useful in their disciplines.

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

COs No	Course Outcomes	Bloom's Taxonomy	
		Level	Descriptor
CO1	**describe** and **recall** the basics of vector algebra, **apply** it to **calculate** directional derivative,divergence, and curl of vector function.	3	Apply
CO2	**understand** the concept vector integration, **analyze,** and **apply** it to solve engineering problems	3	Apply
CO3	**using** Green's theorem, Stoke's theorem, Gauss's Divergence theorem.	4	Analyze
CO4	**Analyze** data, **find** mean, correlation, regression, and **Test** hypothesis with suitable method.	4	Analyze
CO5	**characterize** probability model and function of discrete random variables based on one and tworandom variables**.**	4	Analyze
CO6	**characterize** probability model and function of continuous random variables based on one and tworandom variables.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	1	1	1	-	-	-	-
CO2	3	2	-	-	-	-	-	1	1	1	-	-	-	-
CO3	2	3	-	-	1	-	-	1	1	1	-	-	-	-
CO4	3	2	-	-	-	-	-	1	1	1	-	-	-	-
CO5	2	2	-	-	-	-	-	1	1	1	-	-	-	-
CO6	3	3	-	-	-	-	-	1	1	1	-	-	-	-

COURSE CONTENTS

Unit No.	Unit Title	No. of Hrs.	COs
I	**VECTOR DIFFERENTIATION:** Scalar and vector point function, Derivative of a vector point function, Gradient of scalar function ∅, Directional derivative, Divergence and Curl of vector point function, Solenoidal and irrotational vector field and scalar potential, vector identities.	08	1
II	**VECTOR INTEGRATION:** Line integral, Greens theorem, Work done, Conservative field, surface integral, Stokes theorem, volume integral, Gauss Divergence theorem.	08	2
III	**BASIC STATISTICS** Measures of Central tendency, Moments, Skewnes and Kurtosis, Correlation, and regression	08	3
IV	**DISCRETE RANDOM VARIABLES** Probability mass function and Distribution function, Mathematical Expectation, Variance & Standard Deviation, Binomial distribution, Poisson distribution, Joint distributions, Independent Random variables.	08	4
V	**CONTINUOUS RANDOM VARIABLES** Cumulative probability function and Distribution function, Mathematical Expectation, Variance & Standard Deviation, Normal distribution, Covariance and Correlation, Joint distributions, Independent Random variables.	08	5
VI	**FOURIER TRANSFORM** Definition of Fourier transform, Properties of Fourier transform, Fourier Cosine transform, Fourier sine transform, Inverse Fourier transform	08	6

TextBook(s):

1. B. S. Grewal, Higher Engineering Mathematics, 42/e, Khanna Publishers, 2012, ISBN-13: 978-8174091154.
2. N. P. Bali and Manish Goyal, A TextBook of Engineering, Mathematics, 8/e, Lakshmi Publications, 2012. ISBN: 9788131808320.
3. H. K. Das, Engineering Mathematics, S Chand, 2006, ISBN-8121905209

References:

1. K.A. Stroud & D. S. Booth, Advanced Engineering Mathematics, Industrial Press, 5/e, 2011, ISBN-9780831134495.
2. P. C. Matthews, Vector Calculus, Springer, 2/e, 2012, ISBN-9783540761808.
3. Robert C. Wrede, Introduction to vector and tensor analysis, Dover, 2013, ISBN-048661879X.
4. W. E. Boyce, R. C. Diprima, Elementary differential equation and boundary value problems.
5. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House, 2014. ISBN-13: 978-1842653418.

PC: (PC4105): THEORY OF MACHINES LAB

Teaching Scheme	Examination Scheme
Practical: 02 Hrs./ Week	**Oral Exam: 50 Mark**
Credits: 01	**Total Marks: 50 Mark**

Prerequisite Course: Fundamentals of Engineering Mechanics and Mathematics

Sr. No.	Course Objectives
1	Students will know the various types of links, pairs, and mechanisms.
2	Students can find velocity and acceleration of mechanisms using graphical methods.
3	Students will be able to synthesis mechanism and find out different positions.
4	Student can be able to find different couples acting on rotating disc.

Course Outcomes (COs): At the end of the course students will be able to:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To understand kinematics linkages and working of mechanisms in real life applications.	3	**Analyze**
2	To do draw velocity and Acceleration diagram of simple mechanisms up to 6 linkages.	3	**Analyze**
3	To synthesize the mechanism up to three precision positions.	3	**Analyze**
4	To determine the effect of active gyroscopic couple on a spinning disc.	3	**Analyze**

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	2	2	3		1	2	1		1
CO2	3	2	2	2	3	2		2	2	2		2
CO3	2	2	2	2	3	3		2	2	1	2	1
CO4	3	3	2	2	2	3		2	2	2		2

List of Experiments: Laboratory work

1. Group A : Assignments:

i. To study of various mechanisms and to determine types of pairs, links, and degrees of freedom.

ii. To solve two problems on velocity and acceleration analysis using relative velocity and acceleration method.

iii. To solve two problems on velocity analysis using ICR method.

	iv. To synthesize the four bar and slider crank mechanism using relative pole and inversion method with three accuracy points.
2.	**Group B : Experiments:** i. Speed and torque analysis of epicyclic gear train to determine holding torque. ii. Determination of the effect of active gyroscopic couple on a spinning disc and verify the gyroscopic effect.
3.	**Group C: Software based assignments: (Any Two)** i. To design a simple planer mechanism by using any software. (Any Software MATLAB/ Geogebra) ii. To do computer programming on kinematic analysis of slider crank mechanism using Analytical Method. (Any Software MATLAB/ Geogebra) iii. To synthesize the four bar and slider crank mechanism using relative pole and inversion method with three accuracy points. (Geogebra) iv. To do computer programming on synthesis of mechanism using Chebychevs spacing, Freudensteins equation and function generation. (Python/ Matlab)
4.	**Group D : Virtual Lab:** i. Mechanics-of-Machines Lab (All Experiments) ii. Mechanisms and Robotics > Oldham Coupling Mechanism iii. Mechanisms and Robotics > Quick Return Mechanism iv. Mechanisms and Robotics > CAM Follower Mechanism
5.	**Group E: Industry/Workshop visit:** The Visit to the industries consisting of automation like Assembly line, Sugar factory, Bottle feeling plants etc is mandatory to provide awareness and understanding of the course.
6.	**Self-Learning:** i. To study various types of gearboxes. ii to make a model of any mechanism by using waste material by the group of 4 to 6 students. and to give presentation using PPTs.

PC: (PC4006): MICROCONTROLLER AND EMBEDDED C PROGRAMMING

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100 Marks**

Prerequisite Course: Concepts of Digital Electronics, Basics of C programming

Course Objectives:

Sr. No.	Course Objectives
1	To introduce the architecture, fundamental and features of typical microcontrollers
2	To introduce the wide scope and applications of embedded C in microcontroller system
3	To understand basic concepts of 8-bit microcontroller.
4	Interfacing of real world input and output devices to develop solutions to real world problems
5	Study hardware and software development tools for developing embedded applications using open source embedded platform.

Course Outcomes (COs): At the end of this course, students will be able to, :

CO. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Interpret different architectural features of Microcontroller and Microcontroller families	2	Understand
2	Experiment, Write and simulate programs in embedded C for specific application.	3	Apply
3	Summarize architecture and features of 8051 family of microcontroller	2	Understand
4	Interpret and perform different real life I/O interfacing applications with 8051 microcontrollers.	3	Apply
5	Integrate an application on open source embedded platform	3	Apply
6	Design and demonstrate the engineering solutions to complex problems through the projects	4	Analyze
7	Communicate with engineers and the community at large in written an oral form.	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	-	-	-	-	-	-	-	2	3	2	-
CO2	2	2	2	2	2	-	-	-	-	-	-	2	2	1	-
CO3	3	1	2	2	2	-	-	-	-	-	-	1	2	1	-
CO4	2	2	3	2	2	-	-	-	-	-	-	2	1	2	-
CO5	2	2	2	2	3	-	-	-	-	-	-	1	2	1	-
CO6	1	-	3	1	3	-	-	-	-	-	-	3	3	-	-
CO7	2	-	2	2	-	-	-	-	3	3	-	3	3	-	-

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Introduction to Microcontroller and its architecture:** Introduction to the concept of microcontrollers, RISC, CISC, Harvard and Von Neumann architectures. Role of embedded systems. Selection of microcontrollers, variants of different Microcontroller family and their features. Applications of microcontrollers. Architecture of generalized Microcontroller. Working of Microcontroller, Concept and future trends in Microcontroller, Concept of IP core.	08	1
II	**Introduction to Embedded C:** Introduction to simulation, debugging, and testing, programming concepts: variables, functions, conditional statements, memory map, MACROs, accessing different register, Concept of Scalability, and portability. Process of Embedded C to Assembly conversion with case study.	08	2
III	**8051 Architecture, Addressing modes and Instructions:** Microprocessors and Microcontrollers, CISC and RISC Processors, Harvard and Von Neumann Architectures, MCS-51 architecture, Pin description, PSW, Internal and external memories, Counters and Timers, Serial communication, Stack and Stack Pointer, Port Structure, Interrupts. 8051 Addressing modes, MCS-51 Instruction set and simple assembly language programs.	08	3
IV	**Real World Interfacing with 8051 using Embedded C:** Interfacing 8051 to LED, switches, relay and buzzer, Interfacing 8051 to LCD, Interfacing 8051 to keypad, Interfacing 8051 to Stepper motor, Interfacing 8051 to ADC and DAC, Interfacing serial port of 8051 to PC	08	4
V	**Open source embedded platforms and applications:** Survey of different open source hardware platforms and its variants with special focus on Arduino family, Atmega 328P- features, architecture, port structure, Concept of sensors and actuators, data acquisition systems, Introduction to Arduino IDE- features, IDE overview, Case Study : Multi-core Architecture and System on Chip (SOC).	08	5

Textbooks:

1. Mazidi, Mckinley, Causey, “PIC Microcontrollers and Embedded Systems”, Pearson Education, (1st Edition), (2013), ISBN: 978-81-317-1675-5
2. Mohammad Mazidi, Janice Mazidi and Rolin McKinlay, “The 8051 Microcontroller and Embedded Systems using Assembly and C”, Pearson Education, (2nd Edition), (2014), ISBN : 978-81-317-1026-5
3. David E. Simon, “An Embedded Software Primer”, Addison Wesley; 2nd edition, ISBN: 978-02-016-1569-2

4. Raj Kamal, “Embedded Systems: Architecture, Programming and Design”, Tata McGraw-Hill Education (India), 2011.

Reference Books:

1. Myke Predko, “Programming and customizing the 8051 microcontrollers”, Tata McGraw Hill. (2nd Edition), (2014), ISBN: 978-00-704-2140-0
2. Kenneth Ayala “The 8051- Architecture, Programming and Applications”, West Publishing Company, (3rd Edition), (2014), ISBN: 978-03-147-7278-7 (AICTE)
3. Frank Vahid, Tony Givargis, “Embedded System Design: A Unified Hardware/Software Introduction”, Wiley- India,(2009) ISBN:- 978-81-265-0837-2.
4. Massimo Banzi, Michael Shiloh, “Getting Started with Arduino - The Open Source Electronics Prototyping Platform”, Shroff/Maker Media; 3rd edition 2014, ISBN: 978-93-511-0907-5

E-Resources: https://nptel.ac.in/courses/108/105/108105102/, https://nptel.ac.in/courses/108/102/108102169/

CIA Topics:

Micro-Project activity was given to the students in a group of 4, some of the project titles are given below.

1. Tracker's dark night shoes.
2. Aeroponic farming
3. Hand Simulation Open CV
4. Heart attack detection
5. Fruit spoilage detection kit
6. Writing Mechanism
7. Autonomous Vacuum Cleaner
8. Milk Adulterations system
9. Re-visiting 6 DoF Robotic Arm using open source.
10. 3D Scanner
11. Smart glass for blind
12. Self-Parking Chair
13. Soil Moisture Based Pump Controllers
14. Automated solar panel cleaner
15. Alcohol detector
16. Fire Alarm
17. Automatic Water Filling and Quality Checking
18. Milk spoilage measurement kit
19. XY mechanism using a single servo motor.
20. Physical hologram

PC: (PC4106): MICROCONTROLLER AND EMBEDDED C PROGRAMMING LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Practical Exam: 25 Mark**
Credits: 01	**Total Marks: 25 Mark**

Prerequisite Course: Digital Electronics, Basics of C programming

Sr. No.	Course Objectives
1	Students will know the basic arithmetic operations using simulation package.
2	Students will test interfacing of various I/O devices with microcontroller
3	Students will be able to design simple data acquisition system using open source hardware

Course Outcomes (COs): At the end of this course, students will be able to, :

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To perform various mathematical operations using embedded C	3	Apply
2	To explore the interfacing of advanced I/O components with 8051	3	Apply
3	To design data acquisition system using open source hardware platform	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	---	1	-	3	-	---	2	2	-	---	2	3	---	
CO2	3	---	1	-	3	-	---	2	2	-	---	2	3	---	
CO3	3	---	1	-	3	-	---	2	2	-	---	2	3	---	

List of Experiments: Laboratory work

1. Write an embedded C program to perform various arithmetic operations using simulation package.
2. Write an embedded C program to convert HEX to ASCII and ASCII to binary code using simulation package.
3. Write an Embedded C program for interfacing of LCD with 8051
4. Write an Embedded C program for interfacing of Stepper motor with 8051.
5. Write an Embedded C program for interfacing of 4X4 keypad with 8051.
6. Write an Embedded C program for temperature sensor and ADC interfacing with 8051.
7. Write an embedded C program for interfacing of LED, relay & buzzer with 8051.
8. Data Acquisition System using Sensor and Arduino

BS: (BS4007): MICROPROCESSOR & SYSTEM PROGRAMMING

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100 Marks**

Prerequisite Course: Fundamentals of Microprocessor & System Programming.

Course Objectives:

Sr. No.	Course Objectives
1	To understand the fundamentals of microprocessor.
2	To study the applications of microprocessor.
3	To introduce the architecture and features of 8086 microprocessor.
4	To understand the fundamentals of system programming.
5	To understand the working of assembler, linkers and loaders and compilers.
6	To introduce the fundamental architecture of Raspberry Pi operating system.

Course Outcomes (COs): At the end of the course students will be able to:

CO.No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Understand the basics of microcomputer and microprocessor.	3	Understand
2	Describe the functional blocks, interrupt structure and memory mapping of 8086 microprocessor.	4	Understand
3	Apply the concepts of assembly language programming in microprocessors.	3	Apply
4	Understand the fundamentals of system programming.	3	Understand
5	Implement concepts of assembler, compiler, linker, and loader.	3	Apply
6	Describe the architecture and functional blocks of Raspberry Pi operating system.	3	Understand

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO2	3	3	-	2	2	-	-	-	-	-	-	2	3	-
CO3	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO4	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO5	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO6	3	3	2	2	-	-	-	-	-	-	-	2	3	-

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**INTRODUCTION TO MICROCOMPUTER SYSTEM** **Microcomputer:** CPU, I/O devices, clock, memory, bussed architecture, tri-state logic, address bus, data bus and control bus. **Semiconductor Memories**: MROM, ROM, EPROM, EEPROM,DRAM	08	1
II	**INTRODUCTION TO MICROPROCESSOR** **Introduction to Microprocessor, Selection of correct microprocessor for specific application.** **8086 architectures:** 8086 architecture- functional diagram, Register organization, memory segmentation, programming model, Memory addresses, physical memory organization, Signal descriptions of 8086-common function signals, timing diagrams, Interrupts of 8086.	08	2
III	**ASSEMBLY LANGUAGE PROGRAMMING OF 8086** **Instruction formats:** Addressing modes, instruction set, assembler directives. **Macros:** Simple programs involving logical, branch and call instructions. **Sorting:** evaluating arithmetic expressions, string manipulations.	08	3
IV	**SYSTEMS PROGRAMMING** **Introduction:** Components of System Software, Language Processing Activities, Fundamentals of Language Processing **Assemblers:** Elements of Assembly Language Programming a Simple Assembly Scheme, Pass structure of Assemblers, Design of Two Pass Assembler, Single pass assembler **Loaders and Linkers:** Loader Schemes, General Loader Scheme, Absolute Loader Scheme, Subroutine Linkages, Relocation and linking concepts, Direct Linking Loaders, Overlay Structure, Design of absolute and direct linking loader. **Compiler:** Phase structure of Compiler Lexical Analyzer: The Role of the Lexical Analyzer, Input Buffering.	08	4,5
V	**INTRODUCTION TO RASPBERRY Pi OS** Introduction to Raspberry Pi, Comparison of various Rpi Models, Understanding SoC architecture and SoCs used in Raspberry Pi, Pin Description of Raspberry Pi, On-board components of Rpi.	08	6

Textbooks:

1. Hall D. V. “Microprocessor and Interfacing –Programming and Hardware”, Tata McGraw Hill Publication.
2. D.M. Dhamdhere, “Systems Programming and Operating Systems”, Tata McGraw-Hill Publication.

Reference Books:

1. Short K. L., “Microprocessors and Programmed Logic”, Pearson Education Publication.
2. Leland L. Beck “System Software an Introduction to Systems Programming”, Person Education Publication.

E-Resources: https://onlinecourses.nptel.ac.in/noc22_ee12/preview

PC: (PC4107): MICROPROCESSORS AND SYSTEM PROGRAMMING LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Practical Exam: 25 Mark**
Credits: 01	**Total Marks: 25 Mark**

Prerequisite Course: Fundamentals of Microprocessor & System Programming.

Sr. No.	Course Objectives
1	Students will know the instruction sets of microprocessors.
2	Students will ably test assembly codes.
3	Students will know the fundamental of system programming.

Course Outcomes (COs): At the end of the course students will be able to:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Understand the flow of assembly language program.	1	Understand
2	Apply various feature of assembly language programming	3	Apply
3	Describe number system and string operations	1	Understand
4	Understand Linux base commands and shell scripting	1	Understand
5	Design simple lexical analyzer and assembler	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	---	1	1	2	1	---	2	2	2	---	2	3	---
CO2	3	---	1	1	2	1	---	2	2	2	---	2	3	---
CO3	3	---	1	1	2	1	---	2	2	2	---	2	3	---

List of Experiments: Laboratory work

1. Write assembly language program to perform arithmetic operations on two numbers.
2. Write assembly language program to find largest number from given array.
3. Write assembly language program to various string operations.
4. Write assembly language program to count number of positive and negative numbers from the array.
5. A. Study of Basic Linux Commands B. Write a shell scripting on LINUX OS
6. Write C Program to implement Lexical Analyzer for simple arithmetic operation which creates output tables (Uniform Symbol Table or a. Identifier Table b. Literal Table c. Symbol Table).
7. Design of PASS I of two pass assembler for pseudo machine code.

A. Raspberry Pi operating system B. Android mobile operating system C. Study of System calls to list files, directories. D. Study of System calls to handles process.

PC: (PC4008): SENSORS AND INSTRUMENTATION

Teaching Scheme Lectures: 04 Hrs. / Week	Examination Scheme CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 04	Total Marks: 100 Marks

Prerequisite Course: Engineering physics, Basic concepts of mechatronics engineering

COMPETENCY

- **Study of interface circuits for sensors & selection of appropriate sensors in engineering measurement applications.**

Course Objectives:

Sr. No.	Course Objectives
1	To provide fundamental understanding about the human detector sensors and their characteristics
2	To provide a knowledge of interface circuits for sensors
3	To synergies the combination knowledge of sensors & interface circuits in engg applications.
4	To provide understanding of sensors working & collection of bad/usable data for accurat measurements.

Course Outcomes (COs): At the end of the course students will be able to:

CO.No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	To Understand the concept of sensors and its characteristics.	2	**Understand**
CO2	To apply appropriate interface electronic circuits in sensor selection.	3	**Apply**
CO3	To interpret the bad data in interface electronic circuit and battery management in sensor selection.	3	**Apply**
CO4	To use human detector for various industrial applications.	3	**Apply**
CO5	To choose the microphones for the acoustic signal development.	3	**Apply**
CO6	To demonstrate the sensor working precisely and collection of data for accurate measurement. (CIA project work)	4	**Precision** *Dave's 'Psychomotor Domain*

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	1	3	2	2	1	0	1	1	3
CO2	2	3	3	3	3	2	3	0	0	1	0	3
CO3	3	3	3	3	3	2	3	0	0	1	0	3
CO4	2	3	3	1	3	2	2	1	0	1	1	3
CO5	2	3	3	1	3	2	2	1	0	1	1	3
CO6	1	1	2	3	3	3	3	3	3	3	3	3
CO7	1	0	0	1	0	0	0	3	3	3	3	1

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Sensors Fundamentals and Characteristics** Sensors, Signals and Systems; Sensor Classification; Modules of Measurements; Sensor Characteristics, Sensors for mobile communication devices.	08	1
II	**Interface Electronic Circuits I** Input characteristics of interface circuits, Signal conditioners, Sensor's connections, ratio metric circuits Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits,	08	2
III	**Interface Electronic Circuits II** Data Transmission, Noise in Sensors and Circuits, Batteries for Low Power Sensors, Energy harvesting	08	3
IV	**Human detectors** Occupancy sensors, Ultrasonic detectors, Microwave motion detectors, position sensitive detectors, micropower pulse RADAR, optoelectronic motion detectors, PIR, optical presence sensors, 2-D & 3-D pointing devises, Tactile sensors**Compiler:** Phase structure of Compiler Lexical Analyzer: The Role of the Lexical Analyzer, Input Buffering.	08	4,5
V	**Microphones** Microphone characteristics, Resistive microphones, Optical microphones, Piezoelectric microphones, Dynamic microphones	08	6

Textbooks:

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer.
2. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).

3. 4. Frank Lamb, industrial automation hands-on, McGraw-Hill Education

E-Resources: https://onlinecourses.nptel.ac.in/noc22_ee12/preview

CIA Activity:

S.No.	Performance Indicators	Weightage in %
a.	Able to select suitable sensor for given application & studied data sheet of particular sensor. (CO1) C*	10
b.	Able to apply appropriate interface circuits on selected controller.(CO2) C*	10
c.	Able to fix power supply & sensor to the controller accurately & able to evaluate the data quality. (CO3) C*	30

S.No.	Performance Indicators	Weightage in %
d.	Able to use human detector or microphone sensor in mechanized project for particular application (CO4) or (CO5)C*	10
e.	Able to use microphone in mechanized project for particular application (CO5)C*	
f.	Demonstrate the working of appropriate sensors at suitable place on mechanism & precisely show the accurate measurement of reading. [CO6] (P*)	20
g.	Submission of project report in time / attendance and adapt academic integrity [CO7] (A*)	20
Total		**100**

PC: (PC4108): SENSORS AND INSTRUMENTATION LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Term work : 50 Mark**
Credits: 01	**Total Marks: 50 Mark**

Prerequisite Course: Fundamentals of Microprocessor & System Programming

Course Outcomes (COs): At the end of the course students will be able to:

Course Outcome	Statements	Bloom's Taxonomy	
CO1	To use various sensors for defined applications & characteristic calculations of sensors	3	**Apply** (Bloom's)
CO2	To demonstrate the development of interface circuits through the microcontroller and able to collect the characteristic data.	3	**Apply** (Bloom's)
CO3	To demonstrate the development of interface circuits for the use of selected sensor and able to collect the characteristic data.	3	**Apply** (Bloom's)
CO4	To able the interpret results and draw the conclusions acceptably	3	**Apply** (Bloom's)
CO5	To prepare the circuits on breadboards skilfully and able to supply the power to the circuits from various power sources	3	**Precision** *Dave's 'Psychomotor Domain*
CO6	To measure the reading from the CRO and digital multimeter	3	**Precision** *Dave's 'Psychomotor Domain*
CO7	To practice energy conservation and academic integrity.	3	**Valuing (***Krathwohl's 'Affective Domain'***)**

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	0	0	3	2	0	0	0	2	1
CO2	2	3	3	3	0	0	2	0	0	0	0	2
CO3	2	3	0	1	0	2	3	0	0	0	0	2
CO4	0	3	0	2	0	0	0	0	0	3	0	0
CO5	0	0	0	0	2	3	2	0	1	1	1	1
CO6	0	0	0	0	2	3	2	0	1	1	1	1
CO7	0	0	0	0	0	0	3	3	3	0	0	1

List of Experiments: Laboratory work

1. Study of the characteristics of Capacitor Level Sensor for Level Measurement of a Liquid in a Tank.
2. To measure the characteristics of resistance temperature detector(RTD)
3. Measurement of acceleration, velocity and displacement using piezoelectric vibrometer.
4. Study of rotary positioning system using angular decoder.
5. Measurement of output signal characteristics of USW sonar sensor (HC-SR04) (Use of microcontroller is necessary)

6. Development of automated ‘ON-OF’ system by using LDR sensor and measurement of LDR output characteristics.
7. Understanding the interface electronic circuit for variable resistance sensor.
8. Design of sensor with interface electronic circuit.

Virtual lab experiments:

Sr. No.	Experiment Name	Experiment Link(s)
1	Study of the characteristics of Capacitor Level Sensor for Level Measurement of a Liquid in a Tank.	http://sl-coep.vlabs.ac.in/Capacitance/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab
2	Study of the characteristics of Resistance Temperature Detector (RTD).	http://sl-coep.vlabs.ac.in/Rtd/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab
3	Study of the characteristics of a Thermistor.	http://vlab.amrita.edu/?sub=1&brch=282&sim=1511&cnt=1
4	Study of the characteristics of a Thermocouple.	http://sl-coep.vlabs.ac.in/Thermocouple/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab

BS: (BS4005): MATHEMATICS- III

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week Tutorial : 01 Hr. / Week	CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 04	Total Marks: 100 Marks

Prerequisite Course: Linear Algebra and Stochastic Process, Multivariate Calculus

Course Objectives:

Sr. No	Course Objectives
1	To make students familiarize with concepts and techniques of vector calculus, probability, andrandom processes.
2	The intent is to furnish them with the techniques to understand engineering mathematics and itsapplications that would develop logical thinking power, useful in their disciplines.

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

COs No	Course Outcomes	Bloom's Taxonomy	
		Level	Descriptor
CO1	**describe** and **recall** the basics of vector algebra, **apply** it to **calculate** directional derivative,divergence, and curl of vector function.	3	Apply
CO2	**understand** the concept vector integration, **analyze,** and **apply** it to solve engineering problems	3	Apply
CO3	**using** Green's theorem, Stoke's theorem, Gauss's Divergence theorem.	4	Analyze
CO4	**Analyze** data, **find** mean, correlation, regression, and **Test** hypothesis with suitable method.	4	Analyze
CO5	**characterize** probability model and function of discrete random variables based on one and tworandom variables**.**	4	Analyze
CO6	**characterize** probability model and function of continuous random variables based on one and tworandom variables.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	1	1	1	-	-	-	-
CO2	3	2	-	-	-	-	-	1	1	1	-	-	-	-
CO3	2	3	-	-	1	-	-	1	1	1	-	-	-	-
CO4	3	2	-	-	-	-	-	1	1	1	-	-	-	-
CO5	2	2	-	-	-	-	-	1	1	1	-	-	-	-
CO6	3	3	-	-	-	-	-	1	1	1	-	-	-	-

COURSE CONTENTS

Unit No.	Unit Title	No. of Hrs.	COs
I	**VECTOR DIFFERENTIATION:** Scalar and vector point function, Derivative of a vector point function, Gradient of scalar function ∅, Directional derivative, Divergence and Curl of vector point function, Solenoidal and irrotational vector field and scalar potential, vector identities.	08	1
II	**VECTOR INTEGRATION:** Line integral, Greens theorem, Work done, Conservative field, surface integral, Stokes theorem, volume integral, Gauss Divergence theorem.	08	2
III	**BASIC STATISTICS** Measures of Central tendency, Moments, Skewnes and Kurtosis, Correlation, and regression	08	3
IV	**DISCRETE RANDOM VARIABLES** Probability mass function and Distribution function, Mathematical Expectation, Variance & Standard Deviation, Binomial distribution, Poisson distribution, Joint distributions, Independent Random variables.	08	4
V	**CONTINUOUS RANDOM VARIABLES** Cumulative probability function and Distribution function, Mathematical Expectation, Variance & Standard Deviation, Normal distribution, Covariance and Correlation, Joint distributions, Independent Random variables.	08	5
VI	**FOURIER TRANSFORM** Definition of Fourier transform, Properties of Fourier transform, Fourier Cosine transform, Fourier sine transform, Inverse Fourier transform	08	6

TextBook(s):

1. B. S. Grewal, Higher Engineering Mathematics, 42/e, Khanna Publishers, 2012, ISBN-13: 978-8174091154.
2. N. P. Bali and Manish Goyal, A Textbook of Engineering, Mathematics, 8/e, Lakshmi Publications, 2012. ISBN: 9788131808320.
3. H. K. Das, Engineering Mathematics, S Chand, 2006, ISBN-8121905209

References:

1. K.A. Stroud & D. S. Booth, Advanced Engineering Mathematics, Industrial Press, 5/e, 2011, ISBN-9780831134495.
2. P. C. Matthews, Vector Calculus, Springer, 2/e, 2012, ISBN-9783540761808.
3. Robert C. Wrede, Introduction to vector and tensor analysis, Dover, 2013, ISBN-048661879X.
4. W. E. Boyce, R. C. Diprima, Elementary differential equation and boundary value problems.
5. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House, 2014. ISBN-13: 978-1842653418.

MC: (MC4003): INNOVATIONS

Teaching Scheme Lectures: 02 Hrs. / Week	Examination Scheme End Sem Exam: Pass/ Fail
Credits: No Credit	Total Marks: NA

Prerequisite Course: Nil.

Course Objectives:

Sr. No.	Course Objectives
1	To develop strategic thinking to solve social problems
2	Understand the role of innovation and technical change in enterprise and national level economic performance
3	Understand the technological, human, economic, organizational, social, and other dimensions of innovation
4	Understand the effective management of technological innovation requires the integration o people, processes, and technology
5	Recognize opportunities for the commercialization of innovation

Course Outcomes (COs): At the end of the course students will be able to:

CO. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	Understand the role of innovation and technical change in enterprise and national level economic performance	2	Understanding
CO2	Develop strategic thinking to solve social problems	3	Applying
CO3	Recognize opportunities for the commercialization of innovation	6	Create

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	--	--	--	--	--	--	--	---	--	--	--	--
CO2	--	--	--	3	2	--	--	--	---	--	---	--	--	--	--
CO3	--	--	--	--	--	2	2	3	3	3	2	2	2	--	--

Many students, when they enter engineering, are full of enthusiasm to understand new areas, to build systems and to experiment and play with them. This enthusiasm is to be tapped and to direct it to exploration and sustained pursuit by the student, which may result in development of a working system, a prototype, or a device or material, etc. They are expected to come up with novel and useful ideas on social problems. Students may be encouraged to take up projects which are aimed at providing solutions to societal problems, reduce drudgery and improving efficiency in rural work, green technologies, utilization of rural and urban waste, sanitation, and public health, utilizing nonconventional energy sources, technologies for the benefit of the differently abled people and technologies ready to be implemented in the Institute.

Two types of activities may be undertaken under this.

(a) Exposure to social problems (which are amenable to technological solutions)

(b) Design & Innovation (to address above problems)

After this student, be encouraged to undertake technology projects of social relevance

PR: (PR4102): CAPSTON PROJECT

Teaching Scheme Practical: 02 Hrs./ Week	Examination Scheme Term work: 50
Credits: 01	Total Marks: 50

Prerequisite Course: Nil.

Prerequisite Course: Engineering physics, Engg Mathematics, Mechanics, TDET

COMPETENCY

- **Development of variety of mechatronics engineering projects using a wide range of advanced engineering methods and communication of design solutions to a professional standard.**

Capstone Project:

The Capstone Project provides an opportunity for students to engage in high-level inquiry focusing on an area of specialization within the profession. Capstone projects will be inquiry and practice-centered and will draw upon areas of interest to the student and focus from the program such as philosophy, sociology, policy, research, principles of pedagogy, curriculum design, or technology, among others. All capstones aim to bridge theory and practice and are aimed to have an impact on the professional life of students. The aim of the course is to facilitate the development of your Capstone Projects. Students are encouraged to apply and expend knowledge gained on teaching and learning throughout the UG of Mechatronics engg program as part of this process.

COURSE OBJECTIVES

The Capstone Project should demonstrate the depth and extent of knowledge of students. Capstone projects may take a variety of formats (e.g., video, web, traditional text, media) of scholarly work.

During this course, students will:

1. Investigate and evaluate prominent literature connected to the Capstone Project.
2. • Develop an outline for thinking and practice that illuminates and brings insight to an area of the mechatronics engg field.
3. Develop and create practical resources for mechatronics engg settings.
4. Present a clearly articulated investigative framework, while situating projects within established academic practices and/ or ideas.
5. Offer inquiry-based argumentation for educational/curricular change and adaptation where conceptual propositions are tied to in-the-world realities.

Course Outcomes (COs): At the end of the course students will be able to:

Course Outcome	Statements	Bloom's Taxonomy	
CO1	To able to make links across different areas of mechatronics engg knowledge and to generate, develop and evaluate ideas and information to apply these skills for the design of mechatronics products and/or processes	3	Apply
CO2	Apply methods including QFD, Kano analysis and DFMEA to ensure the quality of a mechatronics engg design	3	apply
CO3	Work collaboratively and individually in a professional way to complete advanced mechanical design projects including consideration of the needs of different stakeholder groups	3	apply
CO4	Present and discuss an engineering design proposal in an oral presentation session and in written professional form	4	Analysis
CO5	Analyse and apply key principles in a specialised area of mechatronics design, depending on which project(s) are done.	4	Analysis

CO & PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	3	0	3	2	0	0	0	2	1	1	0	0
CO2	2	3	3	3	0	2	2	0	0	0	0	2	0	1	0
CO3	2	3	3	1	0	1	3	0	0	0	0	2	0	1	0
CO4	2	1	2	0	3	3	2	0	0	0	2	1	2	2	2
CO5	2	0	3	3	2	0	3	3	3	3	2	2	0	2	2

COURSE CONTENTS

	Capstone Project	No. of Hours	Marks	COs
Unit-I	Lists of topics are offered by the teaching staff or students may find through the societal problem definition together with society peoples before the beginning of the 3rd semester. Students can also choose topics themselves and propose them to possible mentor/supervisors or to the HoD. The topic of the capstone project should fit into the UG program and enable to apply theoretical knowledge in practice. At the beginning of the 3rd semester, every student/group must submit his/their application for the capstone project to the mentor for approval using the related template. Projects from the provided list of topics will be approved by default. At the end of the capstone project, the students must write a project report. The project report should follow a scientific structure and consists basically of the following parts: - -Objective of the work	12 Hrs.	50	1,2,3, 4,5

	- State of the art and research - Theoretical foundations and methods - Conceptual part of the work - Practical implementation (in the lab or in the company) - Validation - Summary and Outlook The length of the report should be about 30-40 A4 pages (about 9000-12000 words). The due date for the final version of the report is at least 2 weeks before the official presentation. At the end of the project, all students present their projects results. The presentation is public and mainly addressed to the UG teaching staff, students, and project evaluators. The duration of the presentation is 15-20 min with an additional 10 min discussion in English. In a study project, a complex task with special consideration of theoretical foundations is dealt within a practical example. The results are presented in a project report and an oral presentation. It must be evaluated by at least two lecturers from the academic staff or an interdisciplinary teaching team, whose members can act as coach and mentor. The students have the possibility, in consultation with their supervisor/ mentor, to work together with an external partner. Capstone projects can be individual or team projects. Team projects are limited to a maximum number of 4 students (and should be defined according to the complexity of the study)			
	Assessment: The evaluation of the capstone project work is carried out by the supervisor/mentor along with evaluator responsible. Formative assessment: in laboratory or fab lab Summative assessment: The assessment of the course is: *Written report and oral presentation. Written report to test the ability to use and transfer the acquired knowledge as well as to make judgement and use a proper technical language. * Oral presentation on the project activities. Project report and project presentation of 15-20 minutes (+10 minutes discussion) (course outcome criteria 1-5) In the case of a team assessment, the grade is a group			

PC: (PC5010): DIGITAL SIGNAL PROCESSING

Teaching Scheme Lectures: 03 Hrs. / Week	Examination Scheme CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 03	Total Marks: 100 Marks

Prerequisite Course: Mathematical Calculus, Digital Electronics

Competency: To understand fundamental principles of signals & system and Digital signal processing (DSP) and apply these concepts in the design of various applications of mechatronics system using MATLAB and Digital signal processors

Course Objectives:

Sr. No.	Course Objectives
1	To understand the mathematical interpretation of continuous and discrete time signals and systems in Digital Signal Processing
2	To analyze Linear Time Invariant (LTI) systems in time domain.
3	To introduce students by transforms for analysis of Discrete time signals and systems.
4	To use and understand implementation of digital filters.
5	To introduce the concept of DSP processor and study different signal processing applications using DSP processor

Course Outcomes (COs): At the end of this course, students will be able to:

CO's	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Understand mathematical description and representation of continuous and discrete time signals and systems.	2	Understand
2	Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.	3	Apply
3	Use the different transforms and analyze discrete time signals and systems	2	Understand
4	Design FIR and IIR filter as per given specifications	3	Apply
5	Understand use of digital Signal Processing in real time applications	3	Apply
6	Understand the real life applications of Digital signal Processing.	2	Understand
7	Communicate with engineers and the community at large in written an oral form.	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**3**	**1**	**2**	-	-	-	-	-	-	-	**2**	**3**	**2**	-
CO2	**3**	**3**	**2**	**2**	**3**	-	-	-	-	-	-	**2**	**3**	**1**	-
CO3	**3**	**3**	**2**	**2**	**3**	-	-	-	-	-	-	**1**	**3**	**1**	-
CO4	**3**	**3**	**3**	**2**	**3**	-	-	-	-	-	-	**2**	**2**	**2**	-
CO5	**3**	**2**	**2**	**2**	**3**	-	-	-	-	-	-	**1**	**3**	**1**	-
CO6	**3**	-	**3**	**1**	**3**	-	-	-	-	-	-	**3**	**3**	-	-
CO7	**2**	-	**2**	**2**	-	-	-	-	**2**	**2**	-	**3**	**3**	-	-

Course Contents

Unit No	Unit Title	No.of Hours	COs
I	**Introduction to Signals and Systems, DSP: Introduction and Classification of signals**: Definition of signal and system, Classification of signals, Elementary signals, different signal Operations **Systems:** Definition, Classification: linear and non-linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible. Basic Elements of DSP and its requirements, advantages of Digital over Analog signal Processing.	08	1
II	**Time domain representation of LTI System: System modeling:** Input-output relation, definition of impulse response, Convolution sum for DT-LTI System, Convolution integral for CT-LTI system, computation of convolution integral, Computation of convolution sum. Properties of convolution. Stability and Causality of LTI system	08	2
III	**DFT and Z-Transform:** Introduction to Fourier Transform, DTFT, DFT and FFT , Need of Z-Transform, Convergence of Z-Transform, Basic Z-Transform, Properties of Z-Transform, Inverse Z-Transform and solving difference equation using Z- Transform	08	3
IV	**Design of Digital Filters:** Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method, Design of IIR filters from Analog filters, IIR filter design by impulse invariance method, Bilinear transformation method. warping effect, Butterworth filters.	08	4
V	**Multi rate DSP and Applications of DSP:** Concept of Multirate DSP, Sampling rate conversion by a non-integer factor, Design of two stage sampling rate converter, General Architecture of DSP, DSP processor TMS32067XX(Features and Architecture) Application of DSP in different domain (speech Processing, Music processing, Image processing, unmanned vehicles, biomedical field , Radar processing, Vibration Analysis for Defective Gear Teeth, health analysis of machine using DSP, Wavelet)	08	5

Textbooks:

1. Signals and Systems by Alan V. Oppenheim, Alan S. Wilsky and Nawab, Prentice Hall
2. Simon Haykin and Van Veen, “Signals & Systems”, 2nd Edition, Wiley, 2005
3. Signals and Systems by K. Gopalan, Cengage Learning (India Edition)
4. John G. Proakis, Dimitris G. Manolakis (2007), Digital Signal Processing, Principles, Algorithms, and Applications, Pearson Education / PHI, India.

Reference Books:

1. A.V. Oppenheim, R. W. Schaffer (2009), Discrete Time Signal Processing, Prentice Hall of India, New Delhi.
2. Andreas Antoniou (2006), Digital Signal Processing, Tata McGraw Hill, NewDelhi.
3. M. H. Hayes (2007), Schaums Outlines of Digital Signal Processing, Tata McGraw Hill, India.
4. DeFatta D J, Lucas J G and Hodgkiss W S, “Digital Signal Processing”, J Wiley and Sons, Singapore, 1988

E-Resources: https://onlinecourses.nptel.ac.in/noc21_ee20/preview

CIA Topics:

Video Making activity is conducted on various recent trends in Digital Signal Processing (DSP) as an individual activity. Some of them are listed below.

1. Digital Signal processing used in Global Positioning systems (Gps)
2. RADAR
3. Weather forecasting
4. Speech Recognition
5. SATCOM
6. Audio data compression - Mp3
7. 5G Spectrum
8. Weather forecast (with digital signals and Numerical Analysis)
9. 2D Filtering under Digital Image Processing
10. Image segmentation in Digital image processing
11. Electrocardiogram Analysis (Medical)
12. Biomedicine-Spectral Estimation
13. Color conversion under Digital image processing
14. SONAR system used in real life application.
15. digital image processing in image enhancement
16. Biomedicene (image processing in medical field using dsp
17. TDM to FDM Translator
18. Hearing AID(Medical)
19. ASR for Air Traffic Control
20. Sonar
21. Communication with Submarines
22. Economic forecasting
23. Digital Image processing
24. Used of filters and equalizers in data transmission
25. Contrast adjustment under digital image processing
26. Computer graphics

PC: (PC5110): DIGITAL SIGNAL PROCESSING LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Oral Exam: 25 Mark**
Credits: 01	**Total Marks: 25 Mark**

Prerequisite Course: Mathematical Calculus, Digital Electronics

Course Objectives:

Sr. No.	Course Objectives
1	Students will know the operation of MATLAB tool to perform various signal operations
2	Students will test various mathematical transforms of DSP
3	Students will be able to design digital filters using MATLAB

Course Outcomes (COs): At the end of this course, students will be able to:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To Generate various types of signals and Perform signal operations.	3	Apply
2	To Understand the analytical tools such as Fourier transforms, and Z-Transforms required for digital signal processing.	3	Apply
3	To develop algorithms for designing and implementation of FIR and IIR filters with standard techniques	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	---	1	-	3	-	---	2	2	-	---	2	3	---	
CO2	3	---	1	-	3	-	---	2	2	-	---	2	3	---	
CO3	3	---	1	-	3	-	---	2	2	-	---	2	3	---	

List of Experiments: Laboratory work

1. Generation of Various signals [periodic and Aperiodic] such as sinusoidal, impulse, step, Ramp.
2. Operations on signals such as Addition, Multiplication, Scaling, Shifting, Folding
3. Perform Convolution of time Domain signals.
4. Evaluate 4 Point DFT and IDFT of given Signal.
5. To plot the poles and zeros of a transfer function when the coefficients of the transfer Function are given, study stability of different transfer functions.
6. To study the effect of different windows on FIR filter response.
7. Design IIR filter using bilinear transformation method.
8. To study interpolation and decimation.
9. Implement convolution sum using DSP Processor.
10. Write a program for speech signal enhancement using pre-emphasis filter and speech filtering using bandpass filter.

PC: (PC5011): INDUSTRIAL AUTOMATION

Teaching Scheme	Examination Scheme
Lectures: 04 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 04	**Total Marks: 100**

Prerequisite Course: Engineering physics, Sensors & Instrumentation

Course Objectives:

Sr. No.	Course Objectives
1	To understand various components of state of art automation technologies encountered in modern manufacturing industries
2	To introduces the practical methods of automatic control of machines, processes, and systems.
3	To provide understanding for designing the electro-hydraulic & electro-pneumatic circuits with PLC interface.

Course Outcomes (COs): After successful completion of the course, student will be able to:

CO. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	To understand the factory automation & it's types	2	Understand
CO2	To able to design the hydraulic & pneumatic circuits for industrial applications	3	apply
CO3	To able to design the electro-hydraulic & electro-pneumatic circuits for industrial applications	3	apply
CO4	To illustrate the circuits used for automatic process controls of industrial systems by PLC programming	2	Understand
CO5	To analyze case studies for automatic industrial applications	4	Analysis
CO6	To demonstrate the hard automation circuit design precisely and Integrate PLCs with given circuitry. (Case study work)	4	Precision *Dave's 'Psychomotor Domain*
CO7	To develop CIA case study reports as per cost estimation using academic integrity & able to communicate to outside world effectively.	3	Valuing (*Krathwohl's 'Affective Domain'*)

Mapping of COs to POs & PSOs

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**0**	**0**	**1**	**3**				
CO2	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**0**	**0**	**3**				
CO3	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**0**	**0**	**3**				
CO4	**3**	**3**	**3**	**1**	**3**	**2**	**3**	**3**	**0**	**1**	**3**				
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**				
CO6	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**				
CO7	**0**	**0**	**0**	**1**	**0**	**2**	**3**	**3**	**3**	**3**	**3**				

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Factory Automation and Integration** Basic concepts, types of automation, automation strategies, automation technologies, applications around us and in manufacturing industries.	08hrs	CO1
II	**Design and Operation of Logic Control Circuits for Hydraulics and Pneumatics** Basic elements of hydraulics/pneumatics, fluid power control elements and standard graphical symbols for them, Fluid properties, effect of viscosity and friction in design, hydraulic & pneumatic cylinders, hydraulic & pneumatic valves for pressure, flow & direction control, Circuit design approach and real time examples; sequence operation of two/more than two cylinders as per the design requirement to automate the systems. Hydraulics/pneumatic safety and their applications to clamping, traversing, and releasing operations.	08hrs	CO2
III	**Design and Operation of Electro-Pneumatic Logic Control Circuits** Electro-pneumatic systems, solenoid valves, different sensors, factory automation sensors, electrical sensors, process automation sensors and their interfaces as per application criteria. Circuit design approach using relay logic circuits and real time examples; sequence operation of two/more than two cylinders as per the design requirement to automate the systems. Electro pneumatic & electrohydraulic systems using relay logic circuits.	08hrs	C03
IV	**Industrial Control Systems** Programmable Logic Controllers (PLC) based control system, programming languages & instruction set, ladder logic, functional blocks, structured text, and applications. Human Machine Interface (HMI) & Supervisory Control and Data Acquisition System (SCADA); motion controller, applications of RFID technology and machine vision. PLC with IoT.	08hrs	CO4
V	**Industrial automation applications** Students in a group will carry out micro project on design and implementation of an automatic modular system which can be useful in contemporary automation industries. The methodologies will be followed as first design and simulation of automated systems using Festo Fluid, SIM, SIROS, PLC software and then implementation by using pneumatic controls, electro-pneumatic controls, PLC, and motion controls. The design questions will ask on the similar applications in examination including PLC programming.	08hrs	C05 C06

Textbooks:

1. Groover, M. P., Automation, Production System & Computer Integrated Manufacturing, Pearson Education Asia (2009).
2. Esposito, A., Fluid Power with Applications, Sixth Edition, Pearson Education (2009).
3. Majumdar, S. R., Pneumatic Systems, McGraw Hill (2005).

4. Nakra, B. C., Theory and Applications of Automatic Controls, Revised 2nd Edition, New Age International Publishers (2014).
5. Morriss, S. B., Automated Manufacturing Systems, McGraw Hill (2006).
6. Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing.
7. Garry Dunning Programmable Logic Controller.
8. Programmable Logic Controllers by Frank Petruzella

E-Resources :

1. https://nptel.ac.in/courses/112105124

CIA Activity:

Design & Development of hard automation circuits which is interface with PLC on given case studies.

Sr. No.	Performance Indicators	Weightage in %	Level		
			1	2	3
a	Able to understand the type of factory automation (CO1) C*	5	Needs improvement	Meet expectations	Exceed expectations
b.	Able to design hard automation circuit for given application (CO2) C*	10			
c.	Able to select appropriate electro-hydraulic or electro-pneumatics valves for the given application (CO3) C*	10			
d.	Able to fix the PLC's pin with designed electro-hydraulic or electro-pneumatics circuit & develop PLC code using ladder diagram for the given circuit(CO4) C*	30			
e.	Able to accurately elaborate the given automatic control system (CO5)C*	5			
f.	Demonstrate the working of hard automation circuit with PLC coding & precisely show the accurate movement of the cylinders. [CO6] (P*)	20			
g.	Submission of case study report in time / attendance and adapt academic integrity [CO7] (A*)	20			
Total		**100**			

PC: (PC5111): INDUSTRIAL AUTMATION LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Oral Exam: 50 Marks**
Credits: 01	**Total Marks: 50 Marks**

Prerequisite Course: Engineering physics, Sensors & Instrumentation

Course Outcomes (COs): After successful completion of the course, student will be able to:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	To demonstrate the knowledge of hydraulic & pneumatic circuits & various components.	2	**Understand**
CO2	To design automation circuits using electro-pneumatic & electro-hydraulic circuits	3	**Apply**
CO3	To explore the programming and implementation of programmable logic controllers for automation circuits	3	**Apply**
CO4	To able the interpret results and draw the conclusions acceptably	3	**Apply**
CO5	To prepare the circuits on circuit boards skilfully and able to correctly connects I/Os	3	**Precision** (Dave's)
CO6	To practice energy conservation and academic integrity.	3	**Valuing** (Krathwohl's)

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**	**3**	**3**	**3**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**2**	**0**	**1**	**0**
CO2	**2**	**3**	**3**	**1**	**0**	**2**	**3**	**0**	**0**	**0**	**0**	**2**	**0**	**1**	**0**
CO3	**2**	**1**	**2**	**0**	**3**	**3**	**2**	**2**	**0**	**0**	**2**	**1**	**0**	**2**	**2**
CO4	**0**	**0**	**0**	**0**	**2**	**3**	**2**	**0**	**1**	**1**	**1**	**1**	**0**	**2**	**2**
CO5	**0**	**0**	**0**	**0**	**2**	**3**	**2**	**0**	**1**	**1**	**1**	**1**	**0**	**2**	**2**
CO6	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**3**	**0**	**0**	**1**	**0**	**2**	**2**

List of Experiments: Laboratory work

1. Study hardware and software used in PLC.
2. Implementation of logic gates, arithmetic instruction, on and off delay timers in PLC
3. Study, understand and perform experiments on timers and counters.
4. Study and simulate analog function blocks.
5. Logic implementation for bottle filling application.
6. Direct control of double acting cylinder.
7. Indirect control of double acting cylinder.
8. Single-rod cylinder/pressure intensification.

Virtual lab experiments:

S. No.	Experiment Name	Experiment Link(s)
1	Study and simulate analog and digital function blocks.	http://ial-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering
2	Study, understand and perform experiments on timers and counters.	http://ial- coep.vlabs.ac.in/Expt3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory
3	Logic implementation for traffic control application.	http://ial- coep.vlabs.ac.in/Expt4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory
4	Logic implementation for bottle filling application.	http://ial- coep.vlabs.ac.in/Expt5/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory
5	Study hardware and software used in PLC.	http://plc-coep.vlabs.ac.in/exp1/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab
6	Implementation of logic gates in PLC.	http://plc-coep.vlabs.ac.in/exp2/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab
7	Implementation of arithmetic instruction.	http://plc-coep.vlabs.ac.in/exp7/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab
8	Implementation of on and off delay timers.	http://plc-coep.vlabs.ac.in/exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab

PC: (PC5012): DESIGN OF MACHINE ELEMENTS

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100 Marks**

Prerequisite Course: Strength of Machine Elements, Basics of Mechanical Engineering

Course Objectives:

Sr. No.	Course Objectives
1	To understand the design function and different steps involved in design of machine components.
2	To learn how to choose proper materials for different machine elements depending on their physical and mechanical properties.
3	To understand different types of failure modes, criteria and failure theories and be able to judge which criterion is to be applied for a particular situation.
4	To understand the design of the various types of springs and power screws.
5	Learn different various types of bearing and their selection from manufactures catalogue.
6	Student shall gain design knowledge of the different types of elements used in the machine design process and will be able to design these elements for each application.

Course Outcomes (COs): After successful completion of the course, student will be able to:

O. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Understand failure modes for mechanical elements and design of machine elements based on strength	3	Apply
2	Able to design a system, components for industrial applications.	4	Analyse
3	Ability to design machine components subjected to different types of fluctuating loads	4	Analyse
4	Understand and able to design power screws.	3	Apply
5	Develop an ability to design springs for applications	4	Analyse
6	Able to select bearings from manufactures catalogue as per the application.	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	2	1	3	0	2	0	1	1	0	0
CO2	3	3	2	1	1	2	1	3	0	2	0	1	1	0	0
CO3	3	3	2	1	1	2	1	3	0	2	0	1	1	0	0
CO4	3	2	2	1	2	2	1	3	0	2	0	2	1	0	0
CO5	3	3	2	2	3	2	2	3	0	2	0	3	1	0	0
CO6	3	3	3	3	3	2	2	3	3	3	2	3	1	1	1

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Design of Simple Machine Elements** Introduction to Machine Design, Product life cycle, types of stress, strains, Design considerations - Strength, Rigidity, Manufacture, Assembly and Cost, Standards and codes, Use of preferred series, Factor of safety, Service factor. Design of joints, Use of Design data books.	06 hrs	CO1
II	**Design of Shafts, Keys and Couplings** Shaft design based on strength, torsional rigidity, and lateral rigidity, A.S.M.E. code for shaft design. Hollow shaft, Design of keys and splines. Design of Coupling.	08hrs	CO2
III	**Design for Fluctuating Load** Stress concentration - causes & remedies, fluctuating stresses, fatigue failures, S-N curve, endurance limit, notch sensitivity, endurance strength modifying factors, design for finite and infinite life, cumulative damage in fatigue failure, Soderberg, Gerber, Goodman, Modified Goodman diagrams.	06 hrs	C03
IV	**Power Screws and springs** Forms of threads, multiple start screws, Torque analysis and Design of power screws, Self-locking screw, Stresses in power screws. **Springs**: Types, applications and materials for springs, Stress and deflection equations for helical compression Springs, Style of ends, Design of helical compression and tension springs, Springs in series and parallel, Surge in springs, Design of leaf springs.	06 hrs	CO4
V	**Design of Belt and Chain drive and Bearings** **Belt & Chain drive**: Types of belts and chain drives, Materials and construction of belts and chain drive, geometric relationships for length of belt and chain, selection criteria for chain drive, power rating of belts, concept of slip & creep, initial tension, effect of centrifugal force, maximum power condition, Selection of belts from standard and commercially available manufacturer's catalogue, belt tensioning methods. timing belts. **Rolling Contact Bearings** Types of rolling contact Bearings, Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent bearing load, Load- life relationship, Selection of bearing life, Selection of rolling contact bearings from standard and commercially available manufacturer's catalogue.	08 hrs	C05 C06

Textbooks:

1. Bhandari V.B., Design of Machine Elements, Tata McGraw Hill Publication Co. Ltd.
2. Shigley J.E. and Mischke C.R., Mechanical Engineering Design, McGraw Hill Publication Co. Ltd.
3. Spotts M.F. and Shoup T.E., Design of Machine Elements, Prentice Hall International.
4. Juvinal R.C., Fundamentals of Machine Components Design, John Wiley, and Sons

Reference Books:

1. Black P.H. and O. Eugene Adams, Machine Design, McGraw Hill Book Co. Inc.
2. Design Data - P.S.G. College of Technology, Coimbatore.
3. Willium C. Orthwein, Machine Components Design, West Publishing Co., and Jaico Publications House.
4. D. K. Aggarwal & P. C. Sharma, Machine Design, S.K Kataria and Sons
5. Hall A.S., Holowenko A.R. and Laughlin H.G, Theory and Problems of Machine Design, Schaum's Outline Series.
6. C. S. Sharma and Kamlesh Purohit, Design of Machine Elements, PHI Learing Pvt. Ltd.
7. P. C. Gope, Machine Design: Fundamentals and Applications, PHI Learing Pvt. Ltd.
8. Bhandari, V. B. Machine Design data book, Tata McGraw Hill Publication Co. Ltd.
9. K. Mahadevan, K. Balveera Reddy, Design Data Handbook for Mechanical Engineers, CBS Publishers.

E-Resources :

1. https://nptel.ac.in/courses/112105124

PC: (PC5013): FLUID MECHANICS

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100 Marks**

Prerequisite Course: Engineering Mathematics - I, Engineering Mathematics - II, Engineering Mechanics, Engineering Physics

Course Objectives:

Sr. No.	Course Objectives
1	To study the properties of the fluids.
2	To study the dynamics of fluids.
3	To study the transport of mass, momentum, and energy.
4	To study the applications of the incompressible viscous flow
5	To study the basics of compressible flows

Course Outcomes (COs): After successful completion of the course, student will be able to:

CO. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	Illustrate the fundamental concepts, scope of fluid mechanics, and fluid statics	2	Understand (Bloom's)
CO2	Learn about development and application of differential form of basic equations	3	Apply (Bloom's)
CO3	Illustrate and apply the dimensional analysis and correlation of experimental data	3	Apply (Bloom's)
CO4	Learn about applications for internal and external viscous fluid flow along with boundary layer fluid flow.	3	Apply (Bloom's)
CO5	Analysis and application of one-dimensional compressible flows	3	Apply (Bloom's)
CO6	Apply the knowledge of Fluid mechanics to solve the problem through computation/software	3	Precision (Dave's)
CO7	Adopt the approach to analyze the real world problem of industry standards and academic integrity for report preparation	4	Adopt (Krathwohn's)

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	3	-	1	2	1		1	-	-	-
CO2	3	2	2	2	3	1	-	2	2	2		2	-	-	-
CO3	2	2	2		1	3	-	2	2	1	2	1	-	-	-
CO4	3	3	2	2	2	2	-	2	2	2		2	-	-	-
CO5	3	3	1	2	2	1	-	1	2	1		1	-	-	-
CO6	3	3	1	2	2	1	-	2	2	1		2	-	-	-
CO7	3	3	2	2	2	2	-	2	2	2		1	-	-	-

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Introduction and Fundamental Concepts** Basic concepts: Definition of a fluid, Dimensions and Units, Application of Fluid Mechanics Fluid Properties-Density and Specific gravity, specific weight, viscosity, compressibility, classification of fluids, Surface Tension and Capillarity, Vapour pressure Fluid Statics: Basic equations of fluid statics, Pressure measurement, Hydrostatic forces on submerged surfaces, Buoyancy, and stability of floating bodies	08 hrs	CO1
II	Fluid Kinematics and Fluid Dynamics **Fluid Kinematics:** Description of fluid motion: Langrangian and Eulerian method, Classification of fluid flow: Steady & unsteady, Uniform &non uniform, Rotational and irrotational, Laminar and Turbulent, Compressible & incompressible, Material derivatives and acceleration Types of flow lines: streamline, path line, stream tube and streak lines **Fluid dynamics:** Basic conservation laws: Conservation of mass, Conservation of momentum, Conservation of energy, Euler equation (for an ideal flow), Bernoulli's equation and practical applications: Venturimeter-Orificemeter- Pitot tube, Moment of momentum equations, Vortex Motion	08 hrs	CO2
III	Dimensional Analysis and Similitude Dimensions and Units, Dimensional homogeneity, Buckingham's Π theorem, Method of repeating variables, Significant dimension less groups in fluid mechanics, Modeling, and similitude	08 hrs	C03
IV	Incompressible Viscous Fluid Flow **Internal Flow**: General characteristics of pipe flow, Laminar flow between parallel plate, Laminar flow in pipe: pressure drop and head loss, Effect of gravity on velocity and flow rate in laminar flow, laminar flow in non-circular pipe, turbulent flow in pipe: turbulent shear stress, turbulent velocity profile, Moody charts, Losses. **External Flow**: Drag and lift, Friction and pressure drag, parallel flow over flat plates, flow over cylinders and spheres, Lift. **Boundary Layer flow:** Concept and definitions of boundary layer: Laminar boundary layer, turbulent boundary layer, laminar sub-layer,	08 hrs	CO4

	Boundary layer thickness, Displacement thickness, Momentum thickness, Energy thickness, Separation of boundary layer		
V	Introduction to Compressible Flow Thermodynamic relations of perfect gas, Speed of sound, Pressure field due to a moving source, Basic equations for one-dimensional flow, Stagnation and sonic properties, Normal shocks	08 hrs	C05

Textbooks:

1. R. K. Bansal, "Fluid Mechanics and Hydraulic Machines", Laxmi Publication
2. S. K. Som and G. Biswas, "Introduction to Fluid Mechanics and Machines", Tata McGraw-Hill Publications
3. R. W. Fox, A. T. McDonald, and J. W. Mitchell, "Introduction to Fluid Mechanics", Wiley
4. F. M. White and H. Xue, " Fluid Mechanics", McGraw-Hill
5. J. D. Anderson, Jr., "Modern Compressible flow", McGraw-Hill

Reference Books:

1. Frank M. White, 1999, Fluid Mechanics, 4e,McGraw-Hill
2. Y. A. Cengel and J. M. Cimbala, "Fluid Mechanics", McGraw-Hill
3. V. L. Streeter, E. B. Wylie, and K. W. Bedford, "Fluid Mechanics", Tata McGraw-Hill
4. Vijay Gupta and Santhosh K Gupta, "Fluid Mechanics and its Applications", New Age International Publisher
5. V. Babu, "Fundamentals of Incompressible Flow", CRC Press, 1st Edition, 2010

E-Resources :

1. https://archive.nptel.ac.in/courses/105/103/105103192/
2. https://archive.nptel.ac.in/courses/112/105/112105269/
3. https://archive.nptel.ac.in/courses/112/105/112105171/
4. https://archive.nptel.ac.in/courses/103/102/103102211/
5. https://archive.nptel.ac.in/courses/127/103/127103225/
6. http://web.mit.edu/hml/ncfmf.html
7. http://www.efluids.com/efluids/books/efluids_books.htm
8. http://www.efluids.com/efluids/pages/edu_tools.htm
   https://spoken-tutorial.org/tutorial-search/?search_foss=OpenFOAM+version+7&search_language

PC: (PC5113): FLUID MECHANICS LAB

Teaching Scheme Lectures: 02 Hrs. / Week	Examination Scheme TERM WORK: 50 Marks
Credits: 01	Total Marks: 50 Marks

Prerequisite Course: Engineering Mathematics - I, Engineering Mathematics - II, Engineering Mechanics, Engineering Physics, Programming Language

Course Objectives:

Sr. No.	Course Objectives
1	To apply fluid statics to measure fluid property pressure
2	To verify Bernoulli's equation
3	To understand the fluid flow based on Reynolds number
4	To visualize the fluid flow and determine the losses through open channel and pipes
5	To visualize the fluid flow through convergent-divergent nozzle

Course Outcomes (COs): After successful completion of the course, student will be able to:

CO. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	Determine pressure using application of manometer	3	Apply
CO2	Verify Bernoulli's equation and applications	3	Apply
CO3	Visualize the fluid flow based on Reynolds number	3	Apply
CO4	Draw flow net and calculate the discharge for various channels	3	Apply
CO5	Determine losses through pipes	3	Apply
CO6	Fluid flow analysis through convergent-divergent nozzle	3	Apply

Mapping of COs to POs & PSOs:

CO's	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
CO1	2	1	1	2	2	3	-	1	2	1		1	-	-	-
CO2	3	2	2	2	3	1	-	2	2	2		2	-	-	-
CO3	2	2	2		1	3	-	2	2	1	2	1	-	-	-
CO4	3	3	2	2	2	2	-	2	2	2		2	-	-	-
CO5	3	3	1	2	2	1	-	1	2	1		1	-	-	-
CO6	3	3	1	2	2	1	-	1	2	1		1	-	-	-

List of Experiments: Laboratory work

1. Determination of pressure using manometers
2. Experimental verification of Bernoulli's equation (venturi meter)
3. Determination of Reynolds number and flow visualization of laminar and turbulent flow using Reynolds apparatus

4. Draw flow net using electrical analogy apparatus to calculate discharge for rectangular / enlargement / contraction channel.
5. Determination of minor/major losses through metal/non-metal pipes
6. Investigation of compressible flow through convergent- divergent nozzles

PC: (PC5014): PROGRAMMING IN JAVA

Teaching Scheme	Examination Scheme
Lectures: 02 Hrs. / Week	**CIA : 20 Marks** **End Sem Exam : 30 Mark**
Credits: 02	**Total Marks: 50 Marks**

Prerequisite Course: Basics of Programming.

Course Objectives:

Sr. No.	Course Objectives
1	To study basic object oriented programming concept.
2	To impart fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries, etc.
3	To learn the operator overloading, Inheritance, etc.
4	To familiarize the concepts of packages and interfaces.
5	To introduce the fundamental to facilitate students in handling exceptions.
6	To demonstrate the concept of event handling used in GUI.

Course Outcomes (COs): After successful completion of the course, student will be able to:

No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Describe the basic JAVA programming.	1	Remember
2	Apply the concept of loops and OOPS concepts.	3	Apply
3	Illustrate the concept exception handling.	4	Analyze
4	Develop the small application using OOP.	6	Design
5	Describe the basic JAVA programming	1	Remember
6	Implement the various file operations.	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	2	2	-	-	-	-	-	-	2	-	3	-	2
CO2	3	-	2	2	2	-	-	-	-	-	2	-	3	-	2
CO3	3	-	2	2	-	-	-	-	-	-	2	-	2	-	2
CO4	3	-	2	2	-	-	-	-	-	-	2	-	3	-	2
CO5	3	-	2	3	-	-	-	-	2	-	3	-	3	-	2
CO6	3	-	2	3	-	-	-	-	2	-	3	-	3	-	2

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**INTRODUCTION TO JAVA** **Introduction:** History, architecture and its components, Java Class File, Java Runtime Environment, The Java Virtual Machine, JVM Components, The Java API, java platform, java development kit, , main(), public, static, void, string[] args, statements, white space, case sensitivity, identifiers, keywords, comments, braces and code blocks, variables, variable name. **Data types:** primitive data types, Object Reference Types, Strings, Auto boxing, operators and properties of operators, Arithmetic operators, assignment operators, increment and decrement operator, relational operator, logical operator, bitwise operator, conditional operator.	06	1
II	**DECISION MAKING & LOOPS** **Control Flow Statements:** The If…Else If…Else Statement, The Switch…Case Statement **Iterations:** The While Loop, The Do … While Loop, The for Loop, The For each Loop, Labeled Statements, The Break and Continue Statements, The Return Statement **Classes:** Types of Classes, Scope Rules, Access Modifier, Method Overloading, Constructors, this Instance, super Instance, constants, this instance, static fields of a class, static methods of a class, garbage collection.	06	2
III	**CORE JAVA** **Inheritance:** Derived Class Objects, Inheritance and Access Control, Default Base Class Constructors, this, and super keywords. **Abstract Classes and Interfaces:** Abstract Classes, Abstract Methods, Interfaces, Multiple. **Packages:** Creating Packages, Default Package, Importing Packages, Using A Package. **Multithreading, Exceptions, Byte streams.**	06	3
IV	**JAVA EVENT HANDLING** **Event Handling:** Delegation Event Model, Events, Event classes, Event listener interfaces, Using delegation event model, adapter classes and inner classes. **Abstract Window Toolkit: Layouts:** Flow Layout, Grid Layout, Border Layout, Card Layout.	06	4,5

Textbooks:

1. Balgurusamy E. “Programming with JAVA”, Tata McGraw Hill Publication.

2. DT Editorial Services, “Java 8 Programming Black Book”, Dream Tech Press .
Reference Books:
1. Schildt Herbert, “Java Complete Reference”, Tata McGraw-Hill. 2. Roy Uttam K “Advance Java Programming”, Oxford University Press.
E-Resources: **https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-cs56/**

PC: (PC5114): PROGRAMMING IN JAVA LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Practical Exam: 25 Marks**
Credits: 01	**Total Marks: 25 Marks**

Prerequisite Course: Fundamentals of Java Programming.

Sr. No.	Course Objectives
1	Students will know the basics of java programming.
2	Students will be able to implement core java programs.
3	Students will know the communication of front-end with back-end.

Course Outcomes (COs): After successful completion of the course, student will be able to:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Describe the basic JAVA programming.	1	Remember
2	Demonstrate the basic object oriented programming concept	3	Apply
3	Apply the concept of operator overloading, Inheritance, virtual function.	3	Apply
4	Design small application using AWT.	5	Create
5	Develop the small application using OOP.	6	Design

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	---	1	1	2	1	---	2	2	2	---	2	3	---	**2**
CO2	3	---	1	1	2	1	---	2	2	2	---	2	3	---	**2**
CO3	3	---	1	1	2	1	---	2	2	2	---	2	3	---	**2**
CO4	3	---	1	1	2	1	---	2	2	2	---	2	3	---	**2**
CO5	3	---	1	1	2	1	---	2	2	2	---	2	3	---	**2**

List of Experiments: Laboratory work

1. **Write Java program to print "Hello World".**
2. Write a Java program to display the following pattern.
   *****
   ****
   ***
   **
3. Write a Java program to reverse a string.
4. Find the smallest and largest element from the array.
5. Designed a class that demonstrates the use of constructor and destructor.
6. Write a java program to implement single level inheritance.
7. Write a java program to add two matrices and print the resultant matrix.
8. Write a java program to open a file and display the contents in the console window.
9. Design a calculator based on AWT application.

HSMC: (HS5004): INDUSTRIAL MANAGEMENT

Teaching Scheme	Examination Scheme
Lectures: 02 Hrs. / Week	**CIA : 20 Marks** **End Sem Exam : 30 Mark**
Credits: 02	**Total Marks: 50 Marks**

Prerequisite Course: Theory of Development and Engineering Thinking, Numerical Analysis

Course Objectives:

Sr. No.	Course Objectives
1	Demonstrate comprehension of management's nature, characteristics, and functions, including the principles of management and their evolution.
2	Enable students to define strategic management and its levels and identify the key components of the strategic management process.
3	Attain an understanding of quality and its various types and explore the phases of quality management along with its associated tools.
4	Develop knowledge base about capital structure and finance sources and be able to analyze techniques of capital budgeting.

Course Outcomes (COs): Students able to:

No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Understand the functions of management and their importance in achieving organizational goals.	2	Understand
2	Apply the strategic management process to develop and implement effective corporate, business, and functional level strategies.	3	Apply
3	Analyze different quality management assistance tools and their effectiveness in improving organizational processes.	4	Analyze
4	Analyze different techniques of capital budgeting and apply them to make informed investment decisions for a project.	4	Analyze
5	Evaluate and justify the use of appropriate management principles, strategies, and tools to solve real-world industrial management problems.	4	Analyze

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**	-	**2**	-	-	-	-	-	-	-	**2**	-	-
CO2	**3**	**3**	-	**2**	**2**	-	-	-	-	-	-	**2**	-	-
CO3	**3**	**3**	-	**2**	-	-	-	-	-	-	-	**2**	-	-
CO4	**3**	**3**	-	**2**	-	-	-	-	-	-	-	**2**	-	-
CO5	**3**	**3**	-	**2**	-	-	-	-	-	-	-	**2**	-	-
CO6	**3**	**3**	**2**	**2**	-	-	-	-	-	-	-	**2**	-	-

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Basics of Management:** Introduction, Definition of management, characteristics of management, functions of management - Planning, Organizing, Staffing, Directing, Co-ordination, Controlling, Motivating, Communication, Decision Making, Principles of management – F.W.Taylor, Henry Fayol, Elton Mayo, Administration and management, Nature of management, levels of management, managerial skills, managerial roles, Forms of Organization- Line , Line –staff etc. Forms of ownerships – Partnership, Proprietorship, Joint stock, Co-operative society, Govt. Sector etc., concept of Globalization	06	1
II	**Strategic Management:** Military origins of strategy – Evolution - Concept and Characteristics of strategic management –Defining strategy – Mintzberg's 5P's of strategy – Corporate, Business and Functional Levels of strategy - Strategic Management Process. Preparing an Environmental Threat and Opportunity Profile (ETOP) – Industry Analysis - Porter's Five Forces Model of competition Matrix – GE 9 Cell Model -Balanced Scorecard, Generic Competitive Strategies: Low cost, Differentiation, Focus.	06	2
III	**Quality Management** Definition of quality, goalpost view of quality, continuous improvement definition of quality, types of quality – quality of design, conformance and performance, phases of quality management, Juran's and Demings view of quality, Quality Management Assistance Tools: Ishikawa diagram – Pareto Analysis – Pokka Yoke (Mistake Proofing).quality circles, TQM, Kaizen, Five S (5S), Six sigma Quality Management Standards (Introductory aspects only)- The ISO 9001:2000 Quality Management System Standard- The ISO 14001:2004 Environmental Management System Standard- ISO 27001:2005 Information Security Management System	06	3
IV	**Financial & Project Management:** Capital Structure, Fixed & working capital, Role of Securities and Exchange Board of India (SEBI), function of money market and capital Market, sources of finance. Introduction to capital budgeting, Techniques of capital budgeting. Break even analysis - assumptions, importance, Cost-Benefit analysis, CVP graph, Project Management, Project network analysis, CPM, PERT and Project crashing and resource Leveling.	06	4

Textbooks:

1. I. P. Khanna, "Industrial Engineering and Management", Dhanpatrai publications Ltd, New Delhi.
2. L.C.Jhamb , Savitri Jhamb , Industrial Management – I , Everest Publishing House .

Reference Books:

1. Dinesh Seth and Subhash C. Rastogi, “Global Management Solutions”, Cengage Learning, Second Edition, USA.
2. B. Davis and Margrethe H. Olson, "Management Information Systems", Mc-Graw-Hill International Editions.
3. Azar Kazmi , “Strategic Management & Business Policy “, Tata McGraw Hill, New Delhi
4. M.Y. Khan and P. K. Jain, “Financial Management”, Tata McGraw Hill, New Delhi
5. Ravi M. Kishore, “Project Management”, Tata McGraw Hill, New Delhi

E-Resources: https://nptel.ac.in/courses/112107292

Continuous Internal Assessment Activity (CIA)

The continuous internal assessment activity is based on the survey and reporting of the companies. Moreover, SWAT and BCG analysis for the selected companies.

Rubrics for the CIA Activity

1. Timely submission of report: 30%

2. Group project performance and presentation: 50%

3. Active participation and engagement in class: 20%

PR: (PR5100): IPR and Patents

Teaching Scheme	Examination Scheme
Practical: 02 Hrs. / Week	Termwork : 50 Marks
Credits: 1	Total Marks: 50 Marks

MC: (MC5004): SOLID MODELLING

Teaching Scheme Lectures: 02 Hrs. / Week	Examination Scheme Pass/Fail
Credits: -	Total Marks: -Nil

Prerequisite Course: Strength of Machine Elements, Basics of Mechanical Engineering

Course Objectives:

Sr. No.	Course Objectives
1	To develop the ability to apply Limit, Fits and Dimensional Tolerances, as well as Geometric Tolerances to components and assemblies on Engineering Drawings
2	To develop an ability to Create Solid Models of machine components. The student should be able to apply these skills to the solution of a variety of practical problems and be able to employ their knowledge to solve more complicated problems.
3	To develop an ability to create assembly models and Production Drawings of simple machine parts.
4	To develop an ability to analyze the simple mechanisms by the simulation tools.

Course Outcomes (COs): After successful completion of the course, student will be able to:

O. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	Understand the standards used in Machine Drawing	2	Understand
CO2	Demonstrate Geometrical Dimensions and Tolerances for machine parts	2	Understand
CO3	Apply modelling commands to develop 3D models of any machine components.	3	apply
CO4	Apply Assembly command to machine parts and its production drawing.	3	apply
CO5	Analyse the mechanisms with the help of Simulation Tool	4	Analysis

Mapping of COs to POs & PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	2	0	1	0	0	0
CO2	2	0	0	0	0	0	0	0	0	2	0	1	0	0	0
CO3	2	0	0	0	2	0	0	0	0	2	0	2	0	2	0
CO4	2	0	0	0	2	0	0	0	0	2	0	2	0	2	0
CO5	2	0	0	0	2	0	0	0	0	2	0	2	0	2	0

Course Contents

Unit No	Unit Title	No. of Hours	COs
Unit-I	**Conventions in Machine Drawing** Introduction to machine drawing, Dimensioning technique for machine components, Conventional representation of machine components as per IS code: SP-46 such as screw threads, springs, gears, bearing, tapped holes, knurling, splined shafts, tapers, chamfers, countersunk and counter bores, keys, & welded joints, Surface Roughness Introduction, terminology, machining symbol with all parameters, roughness values (Ra) indicating surface roughness on drawing.	4 Hrs.	CO1
Unit-II	**Limit, Fits and Tolerances** Definitions applied to tolerances, types of tolerance, types of fits, fit system. Geometrical tolerances – Nomenclature, tolerance frame, types of geometrical tolerances & their symbols, indicating geometric tolerances on drawing.	4 Hrs.	CO4
Unit III	**Sketching and Solid modelling** Introduction to Graphic User Interface of modelling software, sketching of simple machine parts in 2D, Parametric solid modelling (3D) using any modelling software.	8 Hrs.	C05 C06
Unit-IV	**Assembly of M/C Parts and Production Drawing** Dimensional and Geometrical Constraints, Assembly of Machine Components, examples- Wheel support assembly, Bench-vice, Universal coupling, Butterfly valve etc. Production drawing techniques in any modelling software.	8 Hrs.	C05
Unit-V	**Simulation of Mechanisms** Kinematic simulation to study displacement, velocity, and acceleration of links in the mechanism like four bar mechanism, slider crank mechanism, cam, and follower etc.	6 Hrs.	C05

Textbooks:

1. Narayana K. L., Kannaiah P., Venkatata Readdy K., “Machine Drawing”, 2nd Edition, New age international Publishers, Delhi, 2008, ISBN 81-224-1917-8.
2. Bhat N. D., Panchal, “Machine Drawing”, Charotar Pub. House, 2000.ISBN: 9380358466.
3. Michael J Rider, “Designing with CREO PARAMETRIC 6.0”, SDC Publication, USA, ISBN: 987-1-63057-300-3.

Reference Books:

1. Gill P. S., “A Textbook of Machine Drawing”, Revised Edition K. Kataria and Sons, New Delhi, 2008, ISBN: 81-85749-79-5.
2. FarazdakHaideri, “Machine Drawing and Computer Graphics”, Nirali Prakashan, Pune, 1998.ISBN: 9380725272

3. Roger Toogood, “Creo Parametric 6.0 Tutorial”, DC Publications,2019. ISBN 978- 1630572853

E-Resources :

1. https://nptel.ac.in/courses/112102304
2. https://nptel.ac.in/courses/112102101

PC: (PC6015): THERMODYNAMICS & HEAT TRANSFER

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100 Marks**

Prerequisite Course: Basic Concepts of Mathematics, Physics, and Chemistry

Course Objectives:

Sr. No.	Course Objectives
1	To learn basic principles, physical laws, and applications of thermodynamics.
2	To learn basic principles, physical laws, and applications of heat transfer.
3	To apply the knowledge of thermodynamics to solve real life problems.
4	To apply the knowledge of heat transfer to solve real life problems.

Course Outcomes (COs): After successful completion of the course, student will be able to:

No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Understand the fundamental concepts of thermodynamics	2	Understand
2	Apply the low of conservation of energy to thermodynamic systems	3	Apply
3	Understand the law of conversion of energy and apply that to thermodynamic system	3	Apply
4	Understand the heat transfer mechanisms	2	Understand
5	Apply the fundament knowledge of heat transfer to real life problems	3	Apply
6	Apply the knowledge of thermodynamics and heat transfer to complete the CIA project	3	Apply
7	To prepare CIA report following the ethics to maintain dignity and integrity.	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	3	3	-	-	-	-	-	-	-	3	-
CO2	3	3	1	3	3	-	-	-	-	-	-	-	3	-
CO3	3	3	1	3	3	3	3	-	-	-	-	-	3	-
CO4	3	3	1	3	3	-	-	-	-	-	-	-	3	-
CO5	3	3	3	3	3	3	3	-	-	1	-	3	3	-
CO6	3	3	3	3	3	3	3	3	3	1	-	3	3	3
CO7	3	3	3	3	3	3	3	3	3	3	-	3	3	3

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Basic Concepts of Thermodynamics:** Thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work. Zeroth law of thermodynamics, concept of temperature and heat. Concept of ideal and real gases.	08	1
II	**First Law of Thermodynamics:** Concepts of Internal Energy, Specific Heat Capacities, Enthalpy. Energy Balance for Closed and Open Systems, Energy Balance for Steady-Flow Systems. Energy Balance for Unsteady-Flow	08	2
III	**Second Law of Thermodynamics:** Thermal energy reservoirs, heat engines energy conversion, Kelvin's and Clausius statements of second law, the Carnot cycle, the Carnot Theorem, the thermodynamic temperature scale, the Carnot heat engine, efficiency, the Carnot refrigerator and heat pump, COP. Clausius inequality, concept of entropy, principle of increase of entropy – availability, perpetual-motion machines, reversible and irreversible processes, Entropy change of pure substances, liquids and solids, and ideal gases. Energy - a measure of work potential, including work potential of energy, reversible work and irreversibility, second-law efficiency, exergy change of a system, energy transfer by heat, work, and mass, the decrease of exergy principle and exergy destruction, energy balance: closed systems and control volumes energy balance.	08	3
IV	**Heat Transfer:** Heat transfer mechanisms. Conduction: Fourier law, basic conduction heat transfer equation, solution for simple geometries with and without heat generation, lumped parameter problems, cooling fins. Convection: dimension analysis for forced and free convection. Radiation heat transfer: basic laws of radiation, radiation exchanges between black bodies and grey bodies, configuration factors, electric analogy. Heat exchangers: types, size problem and rate problem. Application of heat exchangers for waste heat recovery.	08	4
V	**Heat Transfer in Mechatronic Enclosures:** Design of Enclosure. Natural convection/conduction. Forced convection. Closed-loop cooling	08	5

Textbooks:

1. Nag.P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi.
2. Cengel, "Thermodynamics – An Engineering Approach" Tata McGraw Hill, New Delhi.
3. Sonntag, R. E., Borgnakke, C., & Wylen, G. J. V. Fundamentals of thermodynamics: Wiley.
4. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. Fundamentals of Engineering Thermodynamics:

5. Jones, J. B., & Dugan, R. E. Engineering thermodynamics: Prentice Hall.

Reference Books:

1. Potter, M. C., & Somerton, C. W. Schaum's Outline of Thermodynamics for Engineers, McGraw-Hill.
2. Som, S. K Introduction to Heat Transfer. Prentice-Hall of India Pvt. Ltd.
3. Incropera, F. P., DeWitt, D. P., Bergman, T. L., & Lavine, A. S. Fundamentals of Heat and Mass Transfer: John Wiley & Sons.
4. Özısık, M. N. Heat transfer: a basic approach: McGraw-Hill.
5. Holman, J. P. Heat Transfer: McGraw Hill Higher Education.
6. Çengel, Y. A. Heat transfer: a practical approach: McGraw-Hill.
7. Lienhard, J. H., & Lienhard, J.H. A Heat Transfer Textbook: Fourth Edition: Dover Publications Pvt. Ltd. ISBN:978-81-318-0646-3

E-Resources:

https://www.youtube.com/playlist?list=PLyqSpQzTE6M_QOKxVxZ5nQ48gOkzg7zWP
https://www.youtube.com/playlist?list=PL5F4F46C1983C6785

Continuous Internal Assessment Activity (CIA)

The continuous internal assessment activity will consist of Development of Thermodynamics and Heat Transfer experimental setups (real or virtual) and submit the report.

Rubrics for the CIA Activity:

1. Timely submission of report: 30%
2. Group project performance and presentation: 50%
3. Active participation and engagement in class: 20%

PC: (PC6115): THERMODYNAMICS AND HEAT TRANSFER LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Oral Exam: 25 Mark**
Credits: 01	**Total Marks: 25 Mark**

Prerequisite Course: Fundamentals of Engineering Mechanics and Mathematics

Sr. No.	Course Objectives
1	Students will understand the laws of thermodynamics.
2	Students will learn various methods of heat transfer.
3	Students will be able to calculate heat dissipation rate in mechatronic enclosure.

Course Outcomes (COs): At the end of the course students will be able to:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Conduct the experiment to prove zeroth law of thermodynamics	3	Apply
2	Determine work and heat transfer during thermodynamic processes	3	Apply
3	Explain the concept of Availability and determine various performance parameters of thermodynamics heat pump/refrigeration cycles	3	Apply
4	Conduct experiments to determine thermal conductivity of metal and non-metal	3	Apply
5	Conduct experiments to determine heat transfer coefficient in natural and forced convection	3	Apply
6	Conduct experiments to determine Stefan Boltzmann constant and emissivity of surface	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**	**0**	**3**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**0**	**3**	**3**
CO2	**3**	**3**	**0**	**3**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**0**	**3**	**3**
CO3	**3**	**3**	**0**	**3**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**0**	**3**	**3**
CO4	**3**	**3**	**0**	**3**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**0**	**3**	**3**
CO5	**3**	**3**	**0**	**3**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**0**	**3**	**3**
CO6	**3**	**3**	**0**	**3**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**0**	**3**	**3**

List of Experiments: Laboratory work

1. Determine work and heat transfer during thermodynamic processes using the laws of thermodynamics and steady flow energy equation.
2. Explain the concepts of entropy and calculate heat, work, and other important thermodynamic properties for various process.

3. Explain the concept of Availability and determine various performance parameters of thermodynamics heat pump/refrigeration cycles.
4. Determination of Thermal Conductivity of Composite wall
5. Determination of heat transfer coefficient in Natural Convection
6. Determination of heat transfer coefficient in Forced Convection
7. Determination of temperature distribution, fin efficiency in Natural Forced Convection
8. Determination of Emissivity of a Test surface
9. Determination of Stefan Boltzmann Constant

PC: (PC6016): COMPUTER NETWORK & CYBER SECURITY

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100 Marks**

Prerequisite Course: Basics of computer network.

Course Objectives:

Sr. No.	Course Objectives
1	To learn and understand the fundamental concepts of computer network.
2	To learn and understand different techniques for framing, error control and flow control.
3	To learn and understand the various components required to build different networks.
4	To learn and understand all layers of the network.
5	To learn and understand various network protocols.
6	To understand security of network and information.

Course Outcomes (COs): After successful completion of the course, student will be able to:

CO.No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	**Understand** the history and fundamentals of network.	2	Understand
2	Illustrate physical and MAC layer protocol	4	Analyze
3	**Demonstrate** use of various network protocols.	3	Apply
4	**Design** and implement client server architecture using transport layer protocol.	6	Create
5	Understand the network and information security concepts.	2	Understand
6	Develop security system using network technologies.	6	Create

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	1	2	3	1	2	1	1	-	1	-	1	1	2	1		
CO2	1	2	2	-	-	-	-	-	-	-	-	1	2	1		
CO3	1	1	1	1	-	-	-	-	-	-	-	1	2	-		
CO4	1	3	1	-	1	-	-	-	-	-	-	1	3	1		
CO5	1	2	2	1	1	-	-	-	-	-	-	1	3	1		
CO6	2	3	3	1	2	2	-	-	2	-	1	2	3	2	1	

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**INTRODUCTION TO NETWORKING** Introduction, history and development of computer networks, networks topologies. Layering and protocols.	08	1
II	**PHYSICAL & MAC LAYER** Physical Layer: Different types of transmission media, errors in transmission: attenuation, noise. Repeaters. MAC Layer: Aloha, CSMA, CSMA/CD, CSMA/CA protocols. Examples: Ethernet, including Gigabit Ethernet and WiFi (802.11). Time permitting, a quick exposure to Token Ring and to Bluetooth, WiMax may also be included.	08	2
III	**DATA LINK & NETWORK LAYER** Data Link Layer: Error detection (Parity, CRC), Sliding Window, Stop and Wait protocols. Network layer: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Sub netting, Classless addressing, Network Address Translation.	08	3
IV	**TRANSPORT, SESSION, PRESENTATION & APPLICATION LAYER** Transport layer: UDP, TCP. Connection establishment and termination, sliding window revisited, flow and congestion control, timers, retransmission, TCP extensions, etc. Session, Presentation, and Application Layers. Examples: DNS, SMTP, IMAP, HTTP, etc.	08	4
V	**NETWORK & INFORMATION SECURITY** Data Privacy and Data Storage, Concepts of symmetric and asymmetric key cryptography. Sharing of symmetric keys - Diffie Hellman. Public Key Infrastructure. Public Key Authentication Protocols. Symmetric Key Authentication Protocols. Pretty Good Privacy (PGP), IPSec, Firewalls, SOAR/SOR, Edge Computing.	08	5

Textbooks:

1. Andrew S. Tenenbaum, “Computer Networks”, PHI, ISBN 81-203-2175-8.
2. Fourauzan B., "Data Communications and Networking", 5th Edition, Tata McGraw- Hill, Publications, ISBN: 0 – 07 – 058408 – 7.
3. William Stallings; “Cryptography and Network Security-Principles and Practices” 6th Edition , Pearson Education, 2014, ISBN13:9780133354690.

4. Bernard Menezes, “Network Security and Cryptography”, 1st Edition, Cengage Learning, 2010, ISBN 81-315-1349-1.
5. Raef Meeuwisse, “Cybersecurity for Beginners”, 2nd Edition, Cyber Simplicity, 2017, ISBN- 9781911452157.

Reference Books:

1. Kurose, Ross “Computer Networking a Top Down Approach Featuring the Internet”,Pearson,ISBN-10: 0132856204.
2. Matthew S. G, “802.11 Wireless Networks”, O’Reilly publications, ISBN: 81-7656-992-5
3. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks: Architectures and Protocols” Prentice Hall, ISBN-10: 8131706885; ISBN-13: 978-8131706886.
4. Holger Karl and Andreas Willing, “Protocols and Architectures for Wireless Sensor Networks”, Wiley India , ISBN: 9788126533695.
5. Eldad Perahia, Robert Stacey,“Next Generation Wireless LANs”, Cambridge,ISBN-10:1107016762; ISBN-13: 978-1107016767.
6. Efraim Turban, Linda Volonino, Gregory R. Wood “Computer Networking a Top DownApproach Featuring the Internet”, 10th Edition, Wiley; ISBN13: 978-1-118-96126-1.
7. M. Speciner, R. Perlman, C. Kaufman, “Network Security: Private Communications in a Public World”, Prentice Hall, 2002.
8. Michael Gregg, “The Network Security Test Lab: A Step-By-Step Guide”, Dreamtech Press, 2015, ISBN-10:8126558148, ISBN-13: 978-8126558148.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs19/preview
2. https://onlinecourses.nptel.ac.in/noc21_cs16/preview

PC: (PC6017): CONTROL ENGINEERING

Teaching Scheme Lectures: 03 Hrs. / Week	Examination Scheme CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 03	Total Marks: 100 Marks

Prerequisite Course: Fundamentals of physics, circuit theory, Signal processing, Laplace transform, and Differential Equations

Course Objectives:

Sr. No.	Course Objectives
1	To learn and understand the fundamental concepts of control systems & mathematical modelling of a system.
2	To learn and understand feedback control of a system.
3	To learn and understand the concept of time response and frequency response of the system.
4	To learn and understand basics of stability analysis of the system
5	To model a complicated system into a more simplified form to interpret different physical and mechanical systems
6	To identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system.
7	Prepared to learn and apply contemporary technologies for addressing impending challenges for the benefit of organization/society

Course Outcomes (COs): After successful completion of the course, student will be able to:

No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	**Apply** Laplace domain and algebraic equations to illustrate different specification of the system using transfer function concept	3	Apply
2	**Employ** time domain & Frequency domain analysis to **predict and diagnose** transient performance parameters of the system for standard input functions.	3	Apply
3	**Formulate** different types of analysis to explain the nature and stability of the system.	3	Apply
4	**Design** and identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system	3	Apply
5	**Apply** different applications so far studied in different real-time software platforms	3	Apply
6	**Understand** the concepts and techniques involved in designing control schemes for dynamic systems	2	Understand
7	**Core competency** in multidisciplinary field of mechanical, electrical, computer and control engineering to cater to the industry and the research needs	2	Understand

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO2	**3**	**3**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO3	**3**	**3**	**-**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO4	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO5	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO6	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO7	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**3**	**1**

Course Content

Unit-I	**Introduction to Control Systems & Transfer functions**	No. of Hours	Marks	COs
	Basic concepts of a control system, Components of control system with examples, Block diagram representation and reduction methods, Signal Flow Graph. Concept of open loop & closed loop system. Transfer function representation of LTI system, Introduction to Laplace transform in LTI systems, applications of Laplace transform in series RLC circuit and spring and damper action system.	8 Hrs.	20	CO 1
Unit-II	**Time and Frequency domain Analysis of LTI system**	No. of Hours	Marks	COs
	Type and order of system depending on transfer function, Introduction to time response of 1st and 2nd order system. Transient and steady state analysis of second order LTI system with numerical, Frequency domain analysis of LTI system, Frequency domain specifications with numerical, correlation between time and frequency responses.	8 Hrs.	20	CO 2
Unit III	**Stability criteria of LTI system**	No. of Hours	Marks	COs
	Stability of linear control system: Routh's Hurwitz Criterion, Nyquist stability criterion: fundamentals and analysis, Relative stability: gain margin and phase margin. Root Locus technique: Introduction, properties and its construction, Stability analysis with Bode plot.	08 Hrs.	20	CO 3
Unit-IV	**Design of digital Control system**	No. of Hours	Marks	COs
	Discrete Control systems fundamentals: Applications of Z transforms and numerical. State space representation for Discrete time systems, sampling theorem. Design of Control Systems: PI, PD and PID controllers, Design with phase-lead and phase-lag controllers, Lag-lead compensators. Safety in control systems: ISO 13849, RIS, 1SO26262	08 Hrs.	20	CO 4

	Modern Control system	No. of Hours	Marks	COs
Unit-V	Introduction to SCADA (supervisory control and data acquisition), Applications of SCADA in process automation, few industrial applications like bottle filling plant, etc., Introduction to supervisory software like Labview, Industrial process supervision using Labview, Introduction to Process optimization	08 Hrs.	20	CO 6
	Textbooks:			
	1. Farid Golnaraghi, Benjamin C. Kuo, Automatic Control Systems, 9/e, Wiley India. 2. Gopal, Control Systems, 4/e, McGraw Hill Education India Education, 2012. 3. Ogata K., Discrete-time Control Systems, 2/e, Pearson Education. 4. Gopal, Digital Control and State Variable Method, 4/e, McGraw Hill Education India 2012. 5. Norman S. Nise, Control System Engineering, 5/e, Wiley India 6. Ogata K., Modern Control Engineering, Prentice Hall of India, 4/e, Pearson Education, 2002. 7. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 9/e, Pearson Education, 2001.			
	E-Resources: NPTEL – Control Engineering – Prof: Ramkrishna – IIT Madras https://nptel.ac.in/courses/117/105/117105097/			

PC: (PC6117) CONTROL ENGINEERING LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Oral Exam: 25 Mark**
Credits: 01	**Total Marks: 25 Mark**

Prerequisite Course: Fundamentals of MATLAB & LabVIEW

Sr. No.	Course Objectives
1	Students will know the various control system designing methods
2	Students will understand how to connect practical examples with real time examples
3	Students will be able to identify the stability and durability while designing the project

Course Outcomes (COs): At the end of this course, students will be able to, :

CO	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Designing various control tools	3	Apply
2	Apply basic concepts of control theory and run the projects	3	Apply
3	Interpret specific quality in designing a control system	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	2	1	---	2	2	2	---	2	3	---
CO2	2	1	1	1	2	1	---	2	2	2	---	2	3	---
CO3	2	1	1	1	2	1	---	2	2	2	---	2	3	---

List of Experiments: Laboratory work

1. Identification and familiarization of the following components: resistors, inductors, capacitors, diodes, transistors, LED's, Breadboard connections etc.
2. Familiarization of Mechanical components: Gear, Gear trains, Bearings, Coupling, Backlash removal
3. Familiarization with the following components: CRO, DSO, transformer, function generator, multi-meter, power supply.
4. Design and construct a Schmitt trigger using Op-Amp for given UTP 1 and LTP values and demonstrate its working.
5. Design and construct a rectangular waveform generator (Op-Amp 5 relaxation oscillator) for given frequency.
6. To verify truth tables of various logic gates and flip flops.
7. Design and implement Half adder, Full Adder, Half Subtractor, Full Subtractor using basic gates.
8. Realize a J-K Master/Slave Flip-Flop using NAND gates and verify its truth table.
9. To measure the characteristics of LVDT using linear displacement trainer kit.

PC: (PC6018): MANUFACTURING TECHNOLOGIES

Teaching Scheme Lectures: 04 Hrs. / Week	Examination Scheme CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 04	Total Marks: 100 Marks

Prerequisite Course: Basic Mechanical Engineering, Strength of Materials.

COMPETENCY :

Mechatronics engineering students should be able to select the most appropriate manufacturing process for designing and developing mechatronic systems based on their knowledge of materials properties, design requirements, and manufacturing capabilities.

Course Objectives:

Sr. No.	Course Objectives
1	To gain knowledge of metallurgy and the properties of materials.
2	To learn about the casting process for manufacturing components.
3	To develop knowledge of metal forming techniques.
4	To understand the mechanics of metal cutting processes.
5	To acquire fundamental understanding of joining techniques.
6	To learn about advanced manufacturing processes and their real-world applications.

Course Outcomes (COs): At the end of this course, students will be able to, :

No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Classify and compare different materials based on their properties to select appropriate materials for specific manufacturing applications.	2	**Understand**
2	Design and develop pattern and sand mould with gating and riser system for a given component with simple geometries / features	3	Apply
3	Select a metal forming processes for specific applications using knowledge of process parameters, material properties, and tool design.	3	**Apply**
4	Analyze different metal cutting processes for efficiency, quality, and cost-effectiveness using knowledge of cutting tools, machine tools, and cutting parameters.	3	**Apply**
5	Identify metal joining processes and their characteristics and apply appropriate techniques for specific manufacturing applications using knowledge of materials, joint design, and welding parameters.	3	**Apply**
6	select appropriate advanced manufacturing processes for specific applications using knowledge of process capabilities, limitations, and economic feasibility.	3	**Apply**

7	Industrial Visit: Student will visit the report with professional ethics and present its learning though oral and report writing communication.	4	**Adopt (Krathwohl's)**

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	1	1	1	1	1	-	1	2	1	-	**2**	**2**	-	-
CO2	2	2	2	2	3	1	-	2	2	2	-	**2**	**2**	-	-
CO3	2	2	2	-	1	3	-	2	2	1	2	**2**	**2**	-	-
CO4	2	2	2	2	2	2	-	2	2	2	-	**2**	**2**	-	-
CO5	2	2	1	2	2	1	-	1	2	1	-	**2**	**2**	-	-
CO6	2	2	2	3	2	2	-	2	1	2	2	**2**	**2**	-	-
CO7	**1**	2	2	1	1	1	1	2	1	2	2	**2**	**2**		

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Manufacturing properties of the material** Structure of Matter, Metals and Alloys, Deformation and Mechanical properties of material, Control of Mechanical Properties.	08	1
II	**Casting Processes** Pattern, mold, allowances in patternmaking, Gating system, Cooling and solidification in casting, Defects in casting, Sand Casting process.	06	2
III	**Metal Forming Processes** Plastic deformation and yield criteria, mechanics of forming processes, various forming operations, Riveting operation, Hot and cold forming with their advantages and disadvantages, Friction and lubrication in metal forming, defects in metal forming.	06	3
IV	**Machining** Processes Mechanics of Basic machining processes, Machining processes, - Shaping, planning, turning, boring, Drilling, Milling, grinding. tool geometry and nomenclature for single point cutting tool, selection of tool materials and tool life, tool wear and machinability.	06	4
V	**Joining Processes** Basic Joining Process Types of welding-gas welding, arc welding, shielded metal arc welding, GTAW, GMAW, SAW, ESW-Resistance welding (spot, seam, projection, percussion, flash types)-atomic hydrogen arc welding-thermit welding, Flame cutting - Use of Oxyacetylene, plasma cutting. Soldering, brazing and braze welding and their application	06	5
VI	**Advanced Machining Processes** Introduction, classification of advanced machining processes. Principles, Working, Process Parameters, Advantages, Limitations and Application for following processes: Abrasive Jet Machining (AJM), Ultra Sonic Machining (USM), Electric Discharge Machining (EDM), Laser Beam Machining (LBM), Plasma arc machining (PAM), Electron Beam machining (EBM) and Electro Chemical Machining	06	6

	(ECM), Introduction of Additive Manufacturing.		

Textbooks:

5. A G Ghosh A Mallik, Manufacturing Science, East West,2nd Ed. 2010, Accession No. 670.42 Gho-10
6. Hajara Choudhari, Bose S.K. – Elements of workshop Technology Vol. I &II , Asian Publishing House. Accession No. 53056
7. D. K. Singh – Fundamentals of Manufacturing Engineering – Ane's Books. Pvt. Ltd**.** Accession No. 56452
8. P.N.Rao – Manufacturing technology – The Mc Graw hill companies. Edition 1, Accession No. 9466
9. Kodgire V D, Material Science and Metallurgy for Engineers, 1st Ed., Everest, 1991, 669 Kod-91

Reference Books:

1. Serope Kalpakjian, Steven Schmid, Manufacturing Engineering and Technology, 11th Ed., Pearson, 2012 **670.42 Kal-12**
2. Amitabha Ghosh, Ashokkumar Malik, Manufacturing Science, 2nd Ed. ; Vol. ; : East Wast, 2015, **670.42 Ami-15**
3. Rajput R K, Manufacturing Technology Manufacturing Processes, 1st Ed., Laxmi, 2012, 670.42 Raj-12
4. Groover Mikell P, Fundamentals of Modern Manufacturing ; 2nd Ed., 2004, 670 Gro-04

E-Resources:

http://home.iitk.ac.in/~anandh/E-book/
https://www.e-education.psu.edu/matse81/node/2106

https://onlinecourses.nptel.ac.in/noc21_me40/preview

https://onlinecourses.nptel.ac.in/noc20_me41/preview

PC: (PC6118): MANUFACTURING TECHNOLOGY LAB

Teaching Scheme Practical: 04 Hrs./ Week	Examination Scheme Term work: 50 Mark
Credits: 02	Total Marks: 50 Mark

Prerequisite Course: Fundamentals of Engineering Mechanics and Mathematics

Course Objectives:

Sr. No.	Course Objectives
1	To acquire knowledge about the microstructure of metals and its influence on the properties of materials.
2	To develop skills in operating a lathe machine and performing basic operations such as turning, facing, and drilling.
3	To gain an understanding of different manufacturing processes, including casting, molding, and welding, and their applications in industry.
4	To explore advanced manufacturing processes and their potential advantages over traditional manufacturing techniques.

Course Outcomes (COs): At the end of this course, students will be able to, :

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To develop an understanding of the microstructure of metals and their manufacturing properties through observation and analysis of metal samples under a microscope.	2	Understand
2	To gain hands-on experience in operating a lathe machine and performing basic operations such as turning, facing, drilling, and threading.	3	Apply
3	To understand different manufacturing processes such as casting, molding, and welding, and to apply this knowledge to prepare a component using each of these techniques.	3	Apply
4	To explore and study advanced manufacturing processes such as additive manufacturing, Wire EDM, CNC machining, and to understand their applications in modern industry.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	---	1	1	2	1	---	2	2	2	---	---	---	---	---
CO2	3	---	1	1	2	1	---	2	2	2	---	---	---	---	---
CO3	3	---	1	1	2	1	---	2	2	2	---	---	---	---	---
CO4	3	---	1	1	2	1	---	2	2	2	---	---	---	---	---

List of Experiments: Laboratory work

1. Study of metallurgical microscope.
2. Microscopic study of Engineering materials.
3. Machining of mechanical component using lathe machine consisting of facing, Taper turning, boring and treading operation.
4. Practical on resistance spot welding and gas welding operation.
5. Prepare mechanical component using casting operation.

6. Prepare mechanical component using Milling operation.
7. Machining of simple component using CNC lathe machine.
8. Study of Electrochemical machining process. (Virtual Lab)
9. To study influence of process parameters on the Wire EDM (Virtual Lab)
10. Visit to industry having advanced manufacturing facilities.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Study of Electrochemical machining process.	https://mm-coep.vlabs.ac.in/exp/electrochemical-machining-process/
2	To study influence of process parameters on the Wire EDM	https://mm-coep.vlabs.ac.in/exp/wire-edm/
3	Metal forming virtual simulation lab	http://msvs-dei.vlabs.ac.in/home.php

MC: (MC6005): FINITE ELEMENT ANALYSIS

Teaching Scheme Practical: 02 Hrs./ Week	Examination Scheme Audit Course- No credits
Credit: Nil	

COMPETENCY

To understand basic codes of finite element analysis for structural, thermal & modal analysis using Ansys software.

Course Objectives:

After completion of course, students would be able to:

1. Learn the basics steps of FEA.
2. Understand Ansys GUI & import the solid modelling models.
3. Able to apply different meshing & solvers tools of Ansys.
4. Able to complete post- processing of structural, thermal & modal analysis.

Course Outcomes (COs): At the end of this course, students will be able to, :

Course Outcome	Statements	Bloom's Taxonomy	
CO1	Understand the basic steps of FEA	2	Understand
CO2	Select the Ansys GUI & logics	3	Apply
CO3	Apply the different types of meshing & solvers tools for analysis	3	Apply
CO4	Perform the structural, thermal & modal analysis (CIA Activity)	3	Apply
CO5	To develop CIA activity reports as per standard drafting process using academic integrity & able to communicate to outside world effectively.	3	Valuing (Krathwohl's 'Affective Domain')

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	3	0	3	2	0	0	0	2	1	1	0	0
CO2	2	3	3	3	0	2	2	0	0	0	0	2	0	1	0
CO3	2	3	3	1	0	1	3	0	0	0	0	2	0	1	0
CO4	2	1	2	0	3	3	2	0	0	0	2	1	2	2	2
CO5	2	0	3	3	2	0	3	3	3	3	2	2	0	2	2

Course Contents:

Unit-I	**Introduction to finite element method**	No. of Hours	COs
	History, General steps of the finite element method, Derive the element stiffness matrix & equations, Direct equilibrium method, work or energy method, method of weighted residuals, Assemblage of element equations to obtain global or total equations & introduction of boundary conditions, Advantages of the finite element method.	8 Hrs.	CO 1
Unit-II	**Ansys GUI & selection of logic**	No. of Hours	COs
	Operation modes of ansys, Interactive mode , Batch mode, Product launcher, Product settings, Customization /preferences tabs, Launcher menu options, Ansys GUI, Main menu, Toolbar menu, Command prompt, Output window, Save & resume, files, quitting ansys. Selection of logic: Plotting , picking, co-ordinate systems, select logic, components & assemblies. Solid modelling: Building model from top down , Working with Boolean operations, working planes, importing 3-D models	8 Hrs.	CO 2
Unit III	**Meshing & Solvers**	No. of Hours	COs
	Meshing, free meshing or mapped meshing, setting element attributes, setting element type, shape function, Real constants, defining section properties, assigning element attributes before meshing, mesh controls, smart sizing, meshing , concatenation. Material property library, boundary conditions, types of loads, applying loads. Types of solvers, sparse direct solver, Precondition conjugate solver, Frontal solver, multiple solve method	08 Hrs.	CO 3
Unit-IV	**Post-processing & Analysis**	No. of Hours	COs
	Contour plot viewing, contour nodal solutions, Query results, path operations, estimating solution error, percent error, reaction solution, result viewer, Report generator, structural analysis, thermal analysis, modal analysis	08 Hrs.	1,2, 3

Textbooks:	
	Textbooks 1. Daryl L, A First Course in the Finite Element Method, Logan, 2007. 2. 2G Lakshmi Narasaiah, Finite Element Analysis, B S Publications, 2008. 3. Y.M.Desai, T.I.Eldho and A.H.Shah, Finite Element Method with Applications in Engineering, Pearson Education, 2011 4. Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 2002. 5. P., Seshu, TextBook of Finite Element Analysis, PHI Learning Private Ltd. , New Delhi, 2010 6. Training material of Ansys (Help Menu

PR: (PR6105): MINI PROJECT BASED ON PROGRAMING SKILL

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **ORAL : 50 Mark**
Credits: 01	**Total Marks: 50 Mark**

COMPETENCY

- **Development of variety of mechatronics engineering projects using a wide range of advanced engineering methods and communication of design solutions to a professional standard.**

COURSE OBJECTIVES

1. Define and highlight the importance of software project management.
2. Describe the software project management activities.
3. Train software project managers and other individuals involved in software project.
4. Planning and tracking and oversight in the implementation of the software project management process.

Course Outcomes (COs): At the end of this course, students will be able to, :

Course Outcome	Statements	Bloom's Taxonomy	
CO1	Describe and determine the purpose and importance of project mgt from the perspectives of planning, tracking and completion of project	3	Apply
CO2	Compare and differentiate organization structures and project structures	3	apply
CO3	Implement a project to manage project schedule, expenses, and resources with the application of suitable project management tools.	3	apply
CO4	Present and discuss an engineering design proposal in an oral presentation session and in written professional form	4	Analysis
CO5	Analyse and apply key principles in a specialised area of mechatronics design, depending on which project(s) are done.	4	Analysis

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	3	0	3	2	0	0	0	2	1	1	0	0
CO2	2	3	3	3	0	2	2	0	0	0	0	2	0	1	0
CO3	2	3	3	1	0	1	3	0	0	0	0	2	0	1	0
CO4	2	1	2	0	3	3	2	0	0	0	2	1	2	2	2
CO5	2	0	3	3	2	0	3	3	3	3	2	2	0	2	2

COURSE CONTENTS

	Mini Project	No. of Hours	Marks	COs
Unit-I	Lists of topics are offered by the teaching staff or students may find through the societal problem definition together with society peoples before the beginning of the 3rd semester. Students can also choose topics themselves and propose them to possible mentor/supervisors or to the HoD. The topic of the Mini project should fit into the UG program and enable us to apply theoretical knowledge in practice. At the beginning of the 3rd semester, every student/group must submit his/their application for the Mini project to the mentor for approval using the related template. Projects from the provided list of topics will be approved by default. At the end of the Mini project, the students must write a project report. The project report should follow a scientific structure and consists basically of the following parts: - -Objective of the work - State of the art and research - Theoretical foundations and methods - Conceptual part of the work - Practical implementation (in the lab or in the company) - Validation - Summary and Outlook The length of the report should be about 30-40 A4 pages (about 9000-12000 words). The due date for the final version of the report is at least 2 weeks before the official presentation. At the end of the project, all students present their projects results. The presentation is public and mainly addressed to the UG teaching staff, students, and project evaluators. The duration of the presentation is 15-20 min with an additional 10 min discussion in English. In a study project, a complex task with special consideration of theoretical foundations is dealt with within a practical example. The results are presented in a project report and an oral presentation. It must be evaluated by at least two lecturers from the academic staff or an interdisciplinary teaching team, whose members can act as coach and mentor. The students have the possibility, in consultation with their supervisor/ mentor, to work together with an external partner. Mini projects can be individual or team projects. Team projects are limited to a maximum number of 4 students (and should be defined according to the complexity of the study)	12 Hrs.	50	1,2,3, 4,5
	Assessment: The evaluation of the Mini project work is carried out by the supervisor/mentor along with evaluator responsible. Formative assessment: in laboratory or fab lab The assessment of the course is: *Written report and oral presentation. Written report to test the ability to use and transfer the acquired knowledge as well as to make judgement and use a proper technical language.			

	* Oral presentation on the project activities. Project report and project presentation of 15-20 minutes (+10 minutes discussion) (course outcome criteria 1-5) In the case of a team assessment, the grade is a group

PC: (PC7019): ROBOTICS

Teaching Scheme	Examination Scheme
Lectures: 04 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 04	**Total Marks: 100 Marks**

Prerequisite Course: Engineering Mathematics, Control Systems, Industrial Automation

Course Objectives:

Sr. No.	Course Objectives
1	Familiarize with anatomy, specifications, and types of Robots
2	Obtain forward and inverse kinematic models of robotic manipulators
3	Plan trajectories in joint space & Cartesian space and avoid obstacles while robots are in motion
4	Develop dynamic model and design the controller for robotic manipulators
5	Familiarize with different types of mobile robots, kinematic models, motion control and sensors for mobile robots

Course Outcomes (COs): At the end of this course, students will be able to, :

CONo.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Develops a solid foundation in the principles and components of industrial robots, enabling effective analysis and understanding of various robotic systems.	2	Understand
2	Understanding and analyse the motion kinematics of robots using DH parameters	3	Apply
3	Deriving trajectory in space while recognising and avoiding obstacles.	3	Apply
4	Designing the algorithms to model the controlling robotic arm motion	3	Apply
5	Understanding the current applicative framework of robotics in industry	2	Understand
6	Analyse and apply the knowledge of robotic systems in the industrial or research-based projects	3	Apply

Mapping of COs to POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	3	2	3	0	0	0	3			2
CO2	3	3	2	2	2	0	0	0	0	0	0	2			2
CO3	3	3	2	2	2	0	0	0	0	1	0	0			2
CO4	3	3	1	3	2	0	0	0	0	1	0	0	1		2
CO5	2	1	1	1	0	2	1	1	0	0	2	2	1		2
CO6	3	3	3	3	3	2	2	1	3	3	3	3			2

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Introduction to Robots and Robotics** Types of Robots- Manipulators, Mobile Robots-wheeled & Legged Robots, Aerial Robots; Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom. Robot configuration, Classification of robots based on motion control methods and drive technologies, Classification of End effectors, active and passive grippers, selection, and design considerations of grippers in robot.	08	1
II	**Robot Kinematics** Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics Dynamic Modelling: Equations of motion: Euler-Lagrange formulation	08	2
III	**Trajectory planning** Tasks Path Planning Trajectory Planning. Joint space trajectory planning-cubic polynomial, linear trajectory with parabolic blends, trajectory planning with via points; Cartesian space planning, Point to point vs continuous path planning. Obstacle avoidance methods- Artificial Potential field, A* algorithms.	08	3
IV	**Robot Control** Basics of control: Transfer functions, Control laws: P, PD, PID Non-linear and advanced controls (The control problem, Single axis PID control-its disadvantages, PD gravity control, computed torque control.)	08	4
V	**Industrial Applications** Material handling, welding, Spray painting, Machining. Case study- for robotic applications including robot selection considerations for a typical industrial robotics & automation application. Applications in the medical, mining, space, defence, security, domestic, entertainment.	08	5
	Field robotics Locomotion, Key issues for locomotion, Mobile Robot Kinematics (Differential Drive robot), Mobile Robot Workspace, Sensors for Mobile Robots, Sensor classification, Characterizing sensor performance.		

Textbooks:

1. Robert. J. Schilling, “Fundamentals of robotics – Analysis and control”, Prentice Hall of India 1996.
2. Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
3. Introduction to Robotics by S K Saha, Mc Graw Hill Education
4. Ashitava Ghosal, “Robotics-Fundamental concepts and analysis”, Oxford University press.
5. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2003.

Reference Books:

1. Sicilliano, Khatib, “Handbook of Robotics”, Springer
2. John J. Craig, Introduction to Robotics – Mechanics and Control
3. Kevin M. Lynch, Frank C. Park, Modern Robotics Mechanics, Planning and Control
4. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Robotics Modelling, Planning and Control, Springer

E-Resources:

Modern Robotics: Mechanics, Planning, and Control Specialization, https://www.coursera.org/specializations/modernrobotics#courses

PC: (PC7119): ROBOTICS LAB

Teaching Scheme Practical: 02 Hrs./ Week	Examination Scheme Oral: 25 Marks
Credits: 01	Total Marks: 25 Marks

Prerequisite Course: Programming, Analytical Approach and Mathematics III

Course Objectives (CO)

Sr. No.	Course Objectives
1	Develop understanding of robotic arm and Cartesian and Joint space.
2	Gain hands-on experience in the programming for computer vision applications.
3	Hands on experience on embedded coding to control robotic arm

Course Outcomes (COs): At the end of this course, students will be able to, :

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Demonstrate a deep understanding of robotic arm mechanics, Cartesian, and Joint space concepts.	2,3	Understand and Apply
2	Gain practical expertise in programming for computer vision applications using libraries such as OpenCV and TensorFlow	3	Apply
3	Acquire hands-on experience in embedded coding to control robotic arms, integrating microcontroller programming and motor control algorithms.	3	Apply
4	Develop excellent written and verbal communication skills, enabling them to prepare research documents and effectively convey information through reports and verbal communication.	2	Understand and Apply

Mapping of COs to POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	0	0	0	0	0	0	3	2		2
CO2	3	3	2	2	2	0	0	0	0	0	1	0	0		2
CO3	3	3	1	3	2	0	0	0	0	0	1	0	0		2

List of Experiments: Laboratory work

1. Basics of Robotic Arm(from MITSUBISHI) Mechanism, components, and Architecture of it.
2. Study components of a robotic arm and its DH parameters.
3. Forward kinematics and validate using Robo Analyzer.
4. Inverse kinematics of the real robot and validation using Robo Analyzer.
5. Use of open source computer vision programming tool OpenCV.
6. Image Processing using OpenCV.
7. Image Processing for color/shape detection.
8. Positioning and orientation of robot arm.
9. MELFABASIC IV codes for certain applications in Integrated FMS system

PC: (PC7020): MECHATRONICS SYSTEM DESIGN

Teaching Scheme **Lectures: 04 Hrs. / Week**	Examination Scheme **CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 04	**Total Marks: 100 Marks**

Prerequisite Course: Sensors and Instrumentation, Strength of Materials, Theory of Machines

Competency: Mechatronics system design deals with the design of controlled electromechanical systems by the integration of functional elements from a multitude of disciplines. It starts with thinking how the required function can be realized by the combination of different subsystems according to a systematic step-by-step engineering design approach applied to a realistic mechatronics design problem.

Course Objectives:

Sr. No.	Course Objectives
1	To learn modeling and simulation of physical systems
2	To study the Hardware and software requirement of mechatronics
3	To study controls and their design for use in mechatronics system.
4	To study theoretical and practical aspect of computer interfacing and real time data acquisition and control.
5	To study advance concept, future trends and case studies in mechatronics

Course Outcomes (COs): At the end of this course, students will be able to:

No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Elaborate the basics and key elements of Mechatronics system and develop basic modeling for mechatronics system	**2**	**Analyze**
2	Understand the Hardware components of mechatronics	2	**Understand**
3	Understand performance aspect of individual system component	**2**	**Understand**
4	Realize the interfacing of real time mechatronics system and data acquisition using various controllers	**3**	**Apply**
5	Realize the concepts of design of mechatronics system through case studies.	**3**	**Apply**

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**	1	1	1	1	3	1	1	2	1	-	**2**	**3**	-	-
CO2	**2**	2	2	2	3	1	1	2	2	2	-	**2**	**3**	-	-
CO3	**2**	2	2	-	1	3	1	2	2	1	-	**2**	**3**	-	-
CO4	**2**	2	2	2	2	2	1	2	2	2	-	**2**	**3**	-	-
CO5	**2**	2	1	2	2	1	1	1	2	1	-	**2**	**3**	-	-
CO6	**2**	2	2	3	2	2	1	2	1	2	-	**2**	**1**	-	-
CO7	**2**	2	2	3	2	2	1	2	1	2	-	**2**	**3**		

Course Contents

Unit No	Unit Title	No. of Hours	Cos
I	**Mechatronics System Design** Introduction to Mechatronics, Integrated Design Issues in Mechatronics, Mechatronics Key Elements, Advance approach in mechatronics Modeling and simulation of physical system: Simulation and Block diagram, Analogies and impedance Diagrams, electrical systems, mechanical translational systems, mechanical rotational systems, electromechanical coupling, fluid systems	8 Hrs.	I
II	**Hardware Components of Mechatronics System** Number systems in mechatronics, Binary logic, Karnaugh map minimization, transducer signal conditioning and devices for data conversion programmable controller, active vibration control using magnetostrictive transducers, fiber optic devices in mechatronics	8 Hrs.	II
III	**Signal, Systems and Controls** Introduction to Signal, Systems and Controls, System representation, linearization of nonlinear systems, time delay, measure of system performance, root locus, bode plot	8 Hrs.	III
IV	**Real Time Interfacing** Introduction, Elements of a data acquisition and control system, overview of the I/O process, installation of the I/O card and software, installation of the application software, examples	8 Hrs.	IV

V	**Advance Applications in Mechatronics** Sensors for signal conditioning, mechatronics control in automated manufacturing, artificial intelligence in mechatronics, fuzzy logic applications in mechatronics, microsensors in mechatronics, Data acquisition case studies, data acquisition and control case studies	8 Hrs.	V

Textbooks:

1. 1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.).
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education.
3. A Textbook of Mechatronics, R.K.Rajput, S. Chand & Company Private Limited.
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.Andreas

Reference Books:

1.Devdas Shetty, Richard A. Kolk, "Mechatronics System Design," PWS Publishing company
2.Boukas K, Al-Sunni, Fouad M "Mechatronic,Systems Analysis, Design and Implementation," Springer,
3.Sabri Cetinkunt, "Mechatronics with Experiments," 2nd Edition, Wiley
4.Janschek, Klaus, "Mechatronic Systems Design," Springer

4.

E-Resources:

3. **Design of Mechatronics Systems**

   Prof. Prasanna Gandhi | IIT Bombay
   https://onlinecourses.nptel.ac.in/noc21_me129/preview

4. **Mechatronics system design**
   https://in.mathworks.com/solutions/mechatronics.html

CIA Topics:

1. Design, build and test actual mechatronic systems. This could include tasks such as creating robotic devices, automated control systems, or sensor-based mechanisms.
2. CIA Test-1

PC:(PC7120): DESIGN OF MECHATRONICS SYSTEMS LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Oral: 25 Mark**
Credits: 01	**Total Marks: 25 Mark**

Prerequisite Course: Fundamentals of Engineering Mechanics and Mathematics

Sr. No.	Course Objectives
1	To learn modeling and simulation of physical systems
2	Develop programming skills for implementing control algorithms, user interfaces, and communication protocols in mechatronic systems.
3	Develop a comprehensive understanding of the fundamental principles and concepts that combine mechanical engineering, electronics, computer science, and control engineering in mechatronics system design.
4	To study controls and their design for use in mechatronics system.

Course Outcomes (COs): At the end of this course, students will be able to:

CO' No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Elaborate the basics and key elements of Mechatronics system and develop basic modeling for mechatronics system	3	Apply
2	Understand the Hardware components of mechatronics	2	Understand
3	Understand performance aspect of individual system component	2	Understand
4	Realize the interfacing of real time mechatronics system and data acquisition using various controllers	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	---	1	1	2	1	---	2	2	2	---	---	3	---	---
CO2	3	---	1	1	2	1	---	2	2	2	---	---	3	---	---
CO3	3	---	1	1	2	1	---	2	2	2	---	---	3	---	---
CO4	3	---	1	1	2	1	---	2	2	2	---	---	3	---	---

List of Experiments: Laboratory work

1. Case study of Mechatronics Application CDROM/SCANNER
2. To model an industrial pH neutralization system
3. To study active vibration control using magenetostrictive Transducer
4. Simulation of Transfer functions using MATLAB .
5. Simulation of Root locus/Bode plot using MATLAB.
6. Design a system to control temperature of HOT/COLD Reservoir
7. PLC Control system: -Ladder logic Implementation on real time system
8. Mini Project

PC: (PC7021): CAD/ CAM

Teaching Scheme	Examination Scheme
Lectures: 04 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 04	**Total Marks: 100 Marks**

Prerequisite Course: Basic Mechanical Engineering, C++ Programming Language

Competency: Proficient in 3D modelling, G-code programming, and maintenance of CNC machine.

Course Objectives:

Sr. No.	Course Objectives
1	Develop a thorough understanding of the principles and significance of CAD and CAM in product development.
2	Master the skills to create and manipulate 2D and 3D geometric models using CAD software.
3	Gain expertise in using CAM software to generate tool paths for machining operations.
4	Become proficient in operating CNC machines and programming them using G-code.
5	Acquire knowledge and troubleshooting skills for maintaining CAD/CAM systems in manufacturing environments.

Course Outcomes (COs): At the end of this course, students will be able to.:

CO. No.	COURSE OUTCOME (S)	TAXONOMY	
		Level	Descriptor
1	Understand the fundamentals of Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) and their role in the product development process.	2	**Understand (Bloom's)**
2	Create and manipulate 2D and 3D geometric models using CAD software.	3	**Apply (Bloom's)**
3	Understand the principles of Computer-Aided Manufacturing (CAM) and use CAM software to generate tool paths for machining operations.	2	**Understand (Bloom's)**
4	Operate CNC machines and program them using G-code for various machining operations.	3	**Apply (Bloom's)**
5	Understand the principles of CAD/CAM system maintenance and troubleshoot common issues that may arise during operation.	2	**Understand (Bloom's)**
6	Apply the knowledge of CAD/CAM to precisely manufacture the given component.	3	**Precision (Dave's)**
7	Adoption of industry standards and academic integrity for report preparation.	4	**Adopt (Krathwohl's)**

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	2	0	0	0	0	0	0	1	3	3	0
CO2	0	3	1	0	2	0	0	0	0	1	0	1	3	3	0
CO3	2	0	2	0	3	2	0	0	0	1	0	1	3	3	0
CO4	0	0	2	0	3	0	2	0	0	1	1	1	3	3	0
CO5	2	0	2	3	2	0	2	0	0	1	1	2	3	3	0
CO6	2	2	3	3	3	0	0	0	3	3	3	3	3	3	0
CO7	0	0	0	0	0	0	0	0	0	3	3	0	3	3	0

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Introduction to CAD/CAM:** Overview of Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM), Role of CAD/CAM in the product development process, and CAD/CAM integration and data exchange.	08	1
II	**2D/3D Geometric Modelling:** Basic concepts of 2D CAD, Creating and editing 2D sketches, Geometric construction and constraints, Dimensioning and annotation, Introduction to 3D CAD, Creating and modifying 3D models, Parametric modelling techniques, and Assembly modelling and constraints	08	2
III	**Computer-Aided Manufacturing (CAM) Principles:** Overview of CAM systems, CNC machining process, and Tool selection and machining parameters CAM software and tool path generation	08	3
IV	**CNC Machining and G-code Programming:** Introduction to CNC machines and their components, CNC machine operation and safety, Gcode programming fundamentals, and Creating tool paths for milling and turning operations	08	4
V	**CNC Maintenance and Troubleshooting:** Introduction to Machine Maintenance, Maintenance of Mechanical Components, Maintenance of ball screws, bearings, and guideways, Inspection and cleaning of electrical connections, Troubleshooting and Problem Solving, and Preventive Maintenance Planning.	08	5

Textbooks:

1. "CAD/CAM: Concepts and Applications" by P.N. Rao
2. "Mechatronics: Principles and Applications" by Godfrey C. Onwubolu

Reference Books:

3. "Computer-Aided Design and Manufacturing" by M. Groover and E. Zimmers
4. "Maintenance Engineering and Management" by K. Venkataraman

E-Resources:

https://www.youtube.com/playlist?list=PLLvBXFAV-DeLYJkmexmAEo-qb2miY97C_

https://www.coursera.org/specializations/autodesk-cad-cam-manufacturing

Continuous Internal Assessment Activity (CIA)

The continuous internal assessment activity will consist of Development of CAD model of given component and manufacture the same on CNC machine and submit the report.

Rubrics for the CIA Activity:

1. Timely submission of report: 30%
2. Group project performance and presentation: 50%
3. Active participation and engagement in class: 20%

PC:(PC7121): CAD/CAM Lab

Teaching Scheme	Examination Scheme
Practical: 02 Hrs./ Week	**Practical : 25 Marks**
Credits : 01	**Total Marks: 25 Marks**

Prerequisite Course: Basic Mechanical Engineering, C++ Programming Language

Sr. No.	Course Objectives
1	Develop proficiency in designing and analysing mechanical components using CAD software, enabling the creation of robust and functional designs.
2	Master advanced CAD techniques to create accurate and detailed 3D models and assemblies, ensuring efficient and precise representation of complex engineering structures.
3	Acquire the skills to simulate and evaluate the performance of mechanical designs using CAD software, enabling the identification and rectification of potential design flaws before the manufacturing stage.
4	Gain expertise in generating tool paths and G-code for CNC machining operations using CAM software, ensuring the translation of design specifications into precise machining instructions.
5	Learn and apply CAM techniques to optimize machining processes and reduce production time, enhancing efficiency and productivity in the manufacturing workflow.

Course Outcomes (COs): At the end of this course, students will be able to.:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Design and analyse mechanical components using CAD software	3	Apply
2	Create 3D models and assemblies using advanced CAD techniques	3	Apply
3	Simulate and evaluate the performance of mechanical designs using CAD software	3	Apply
4	Generate tool paths and G-code for CNC machining using CAM software	3	Apply
5	Optimize machining processes and reduce production time using CAM techniques	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3		3	3			3	3			3	3	
CO2	3		3		3	3			3	3			3	3	
CO3	3		3	3	3	3			3	3			3	3	3
CO4	3		3	3	3	3			3	3			3	3	3
CO5	3		3	3	3	3			3	3			3	3	3

List of Experiments: Laboratory work

1. Design and analyze mechanical components using CAD software.

2. Create 3D models and assemblies using advanced CAD techniques.
3. Simulate and evaluate the performance of mechanical designs using CAD software.
4. Generate tool paths and G-code for CNC machining using CAM software.
5. Optimize machining processes and reduce production time using CAM techniques.
6. Perform rapid prototyping and additive manufacturing processes using CAM software.
7. Implement maintenance strategies for mechatronic systems.
8. Troubleshoot and diagnose faults in mechatronic systems for maintenance purposes.

MC: (MC7006): FINANCIALLY SMART

Teaching Scheme	Examination Scheme
Practical: 02 Hrs./ Week	**Audit Course- No credits**

Personal Financial Literacy Program for Young Adults - Being Financially Smart	
•A- Google Survey – Pre-session (via email)	
•Unit 1 - Behavioural Finance - 3 hours	•Unit 2 -Money Management Skills - 3 hours
Section 1 – Let's Talk Money	Section 1 – Important Concepts
•1. Psychology of Money	•1. Saving vs Investing
•2. Your Relationship with Money	•2. Inflation
•3. Human Behaviour in Financial Markets	•3. Power of Compounding
Section 2 –Why Financial Literacy?	Section 2 – Money Management Techniques
•4. Importance of Financial Literacy	•4. S.M.A.R.T.E.R way to Wealth
•5. Costly Money Mistakes	•5. 6 - Money Jar Method
Micro-Project 1 - Exercise	
•Unit 3 - Steps of Financial Planning - 3 hours	•Unit 4 – Risk & Investment Management - 3 hours
Section 1 – Let's Start Planning	Section 1 - Risk Management
•1. Need & Components of Financial Planning	•1.Understanding Risk Management
•2. Personal Income Statement– Cashflow Mgt & Net Worth Mgt.	•2. Life Insurance
•3. S.M.A.R.T Goal Setting	•3. Health Insurance
Section 2 - Goal Based Investment Planning	Section 2 - Investment Management
•4. Contingency/Emergency Fund Planning	•4. Asset Allocation
•5. Lifestyle/ Retirement Planning	•5. Mutual Funds - Overview
•6. Estate Planning	•5. Review & Action
Micro-Project 2 - Case Study	
• Unit 5 – Introduction to Business Finance - 3 hours	
•How to Read an Income Statement	
•How to Read a Balance Sheet	
Micro-Project 3 - Case Study	
B- Google Survey (via email)	
Post -session: - 1. Evaluation 2. Feedback 3. Certification	

PR: (PR7106): PROJECT WORK-I

Teaching Scheme Practical: 06 Hrs./ Week	Examination Scheme Oral : 50 Marks Term work: 100 Marks
Credits : 03	Total Marks: 150 Marks

Prerequisite Course: **All coursework till now**

Course Objectives: Students will

Sr. No.	Course Objectives
1	Be proficient in integrating mechanical, electronic, and computer components to design complex mechatronic systems.
2	Develop the ability to identify real-world engineering problems and propose innovative mechatronic solutions that address these challenges.
3	Gain practical experience in building and prototyping mechatronic systems, including the selection of appropriate sensors, actuators, and control algorithms.
4	Enhance their skills in collaborating with peers from diverse engineering backgrounds, effectively communicating and integrating different subsystems.
5	Apply ethical principles in engineering design, with a focus on sustainability and responsible technology development.
6	Develop project management skills, including time management, resource allocation, and risk assessment, to successfully complete mechatronics projects.

Course Outcomes (COs): Students able to

CONo.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Select and integrate mechanical components (e.g., motors, gears, linkages) into mechatronic systems.	2	Understand
2	Choose and interface electronic components (e.g., sensors, microcontrollers, and actuators) within mechatronic systems.	3	Apply
3	Develop control algorithms for mechatronic systems using programming languages (e.g., C++, Python) and control theory.	6	Create
4	Select appropriate sensors for data acquisition in mechatronic applications. Process and analyze sensor data for decision-making and system control.	5	Evaluate
5	Design experiments and conduct systematic testing to validate the performance and functionality of mechatronic systems.	5	Evaluate
6	Maintain comprehensive documentation throughout the project, including design specifications, schematics, and code. Present project progress and results through written reports and oral presentations.	3	Apply
7	Develop project plans with clear milestones and deliverables. Effectively manage project resources, time, and risks to ensure project completion.	3	Apply

Mapping of COs to POs & PSOs: (TBD)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2		2	2	2	2		3	3	2	2	2
CO2	3	3	3	2	3	3	2	2	3	3	3	2	3	3	3
CO3	3	3	2	2		2	2	2	2	3	3	3	2	2	2
CO4	3	3	3	2	3	3	2	2	3	3	3	2	3	3	3
CO5	3	3	2	2		2	2	2	2	3	3	3	2	2	2
CO6	3	3	3	2	3	3	2	2	3	3	3	2	3	3	3

Guidelines for project work

Note: Student must complete the project work in the VIIth semester only.

The primary objective of the project in the Mechatronics Engineering Department is to provide students with a comprehensive understanding of conducting a successful mechatronics industrial or research project. This process encompasses identifying a research problem or engineering challenge that the student aims to tackle through their graduate engineering project. The structured approach to project identification involves several key steps, including brainstorming, problem definition, research question development, feasibility assessment, and proposal development.

The project identification process demands thoughtful consideration of potential research areas or engineering challenges, coupled with an assessment of the practicality and relevance of the proposed project. Students should choose their projects based on a variety of factors, including their personal interests, skill sets, and career aspirations.

Potential project categories within the Mechatronics Engineering Department may include but are not limited to:

1. Experimental Investigations: Conducting experiments within specific domains of mechatronics engineering to advance knowledge and develop practical solutions.
2. Software Development: Creating software applications to address complex engineering problems or enhance mechatronics systems.
3. Working Model Design: Designing and fabricating working models or prototypes, including product development in the field of mechatronics.
4. Industrial Applications: Solving real-world industry problems, addressing environmental concerns, promoting awareness, and proposing sustainable solutions.
5. Soft Computing Methodologies: Developing case studies and methodologies using soft computing tools to address mechatronics challenges.
6. Societal and Agricultural Challenges: Tackling issues that impact society and agriculture, including evaluating new materials and technologies.
7. Industry Collaboration: Undertaking projects in collaboration with industry partners or sponsored by industrial organizations.
8. Cost-Benefit Analysis: Analyzing the economic feasibility of projects and optimizing solutions to meet desired goals.

Additional weightage will be given to projects or research aligned with:

Option A: Industry-Sponsored Projects

Option B: Entrepreneurial Ventures

Option C: Internal Product Development

Option D: National/International Journal Paper Publication

Option E: Patent Filing Based on Project Work

By engaging in mechatronics engineering projects following this structured approach, students can gain valuable experience and contribute to the advancement of knowledge and technology in this field.

It's essential to ensure that the projects align with the intended learning objectives of the full mechatronics engineering coursework. Here are some guidelines for students as well as their **Mentors** for conducting project work:

1. Project Selection *:

- **Alignment with Course Outcomes:** Encourage students to choose projects that align with the course outcomes, emphasizing system integration, interdisciplinary collaboration, and ethical/sustainable design.
- **Problem Statement:** Require students to clearly define the engineering problem they aim to solve through the project, emphasizing the practical application of mechatronics principles.

2. Project Teams *:

- **Interdisciplinary Teams:** Promote the formation of interdisciplinary project teams, comprising students with expertise in mechanical, electronic, and computer engineering.
- **Collaboration:** Emphasize the importance of effective communication and collaboration among team members from diverse backgrounds.

3. Project Planning *:

- **Project Proposal:** Require students to submit a project proposal outlining objectives, milestones, resource requirements, and a timeline. Ensure that project plans align with project management objectives.
- **Risk Assessment:** Encourage students to identify potential risks associated with their projects and develop risk mitigation strategies.

4. Design and Integration ¦:

- **Mechanical Integration:** Emphasize the integration of mechanical components into the mechatronic system, ensuring that students select appropriate components and optimize designs.
- **Electronic Integration:** Guide students in choosing electronic components and designing circuits for data acquisition, control, and communication.

5. Programming and Control ¦:

- **Control Algorithms:** Ensure that students develop control algorithms using programming languages and control theory to meet the project's objectives.
- **Real-Time Control:** Promote the implementation of real-time control strategies for feedback and closed-loop control.

6. Testing and Validation ¦:

- **Experimental Design:** Encourage students to design experiments to systematically test and validate their mechatronic systems.
- **Data Analysis:** Teach students how to process and analyze sensor data to evaluate system performance and refine designs.

7. Documentation and Reporting#:

- **Documentation:** Stress the importance of maintaining comprehensive documentation throughout the project, including design specifications, schematics, code, and experimental results.

- **Reports and Presentations:** Require students to prepare written reports and deliver oral presentations to communicate project progress and outcomes effectively.

8. Ethical and Sustainable Considerations[#]:

- **Ethical Review:** Encourage students to evaluate the ethical implications of their design choices, considering safety, privacy, and societal impact.
- **Sustainability:** Emphasize sustainable design principles, such as energy efficiency and materials selection, and their integration into project designs.

9. Project Management[#]:

- **Project Timeline:** Monitor and guide students in adhering to project timelines and milestones outlined in their project proposals.
- **Resource Allocation:** Teach students effective resource management, including budgeting, procurement, and allocation of materials and equipment.

10. Assessment: See Project Evaluation Document

Indicator	*Stage*	Deadline
*	*Initiation*	20-23/09/2023
!	*Development and Testing*	25-28/10/2023
#	*Submission*	22-25/11/2023

PR: (PR8107): PROJECT WORK-II

Teaching Scheme Practical: 04 Hrs./ Week	Examination Scheme Oral : 50 Marks
Credits : 02	Total Marks: 50 Marks

Prerequisite Course: **All coursework till now**

Course Objectives: Students will

Sr. No.	Course Objectives
1	Be proficient in integrating mechanical, electronic, and computer components to design complex mechatronic systems.
2	Develop the ability to identify real-world engineering problems and propose innovative mechatronic solutions that address these challenges.
3	Gain practical experience in building and prototyping mechatronic systems, including the selection of appropriate sensors, actuators, and control algorithms.
4	Enhance their skills in collaborating with peers from diverse engineering backgrounds, effectively communicating and integrating different subsystems.
5	Apply ethical principles in engineering design, with a focus on sustainability and responsible technology development.
6	Develop project management skills, including time management, resource allocation, and risk assessment, to successfully complete mechatronics projects.

Course Outcomes (COs): Students able to

CONo.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Select and integrate mechanical components (e.g., motors, gears, linkages) into mechatronic systems.	2	Understand
2	Choose and interface electronic components (e.g., sensors, microcontrollers, and actuators) within mechatronic systems.	3	Apply
3	Develop control algorithms for mechatronic systems using programming languages (e.g., C++, Python) and control theory.	6	Create
4	Select appropriate sensors for data acquisition in mechatronic applications. Process and analyze sensor data for decision-making and system control.	5	Evaluate
5	Design experiments and conduct systematic testing to validate the performance and functionality of mechatronic systems.	5	Evaluate
6	Maintain comprehensive documentation throughout the project, including design specifications, schematics, and code. Present project progress and results through written reports and oral presentations.	3	Apply
7	Develop project plans with clear milestones and deliverables. Effectively manage project resources, time, and risks to ensure project completion.	3	Apply

Mapping of COs to POs & PSOs: (TBD)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2		2	2	2	2		3	3	2	2	2
CO2	3	3	3	2	3	3	2	2	3	3	3	2	3	3	3
CO3	3	3	2	2		2	2	2	2	3	3	3	2	2	2
CO4	3	3	3	2	3	3	2	2	3	3	3	2	3	3	3
CO5	3	3	2	2		2	2	2	2	3	3	3	2	2	2
CO6	3	3	3	2	3	3	2	2	3	3	3	2	3	3	3

Guidelines for project work

Note: Student must complete the project work in the VIIth semester only.

The primary objective of the project in the Mechatronics Engineering Department is to provide students with a comprehensive understanding of conducting a successful mechatronics industrial or research project. This process encompasses identifying a research problem or engineering challenge that the student aims to tackle through their graduate engineering project. The structured approach to project identification involves several key steps, including brainstorming, problem definition, research question development, feasibility assessment, and proposal development.

The project identification process demands thoughtful consideration of potential research areas or engineering challenges, coupled with an assessment of the practicality and relevance of the proposed project. Students should choose their projects based on a variety of factors, including their personal interests, skill sets, and career aspirations.

Potential project categories within the Mechatronics Engineering Department may include but are not limited to:

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3. Working Model Design: Designing and fabricating working models or prototypes, including product development in the field of mechatronics.
4. Industrial Applications: Solving real-world industry problems, addressing environmental concerns, promoting awareness, and proposing sustainable solutions.
5. Soft Computing Methodologies: Developing case studies and methodologies using soft computing tools to address mechatronics challenges.
6. Societal and Agricultural Challenges: Tackling issues that impact society and agriculture, including evaluating new materials and technologies.
7. Industry Collaboration: Undertaking projects in collaboration with industry partners or sponsored by industrial organizations.
8. Cost-Benefit Analysis: Analyzing the economic feasibility of projects and optimizing solutions to meet desired goals.

Additional weightage will be given to projects or research aligned with:

Option A: Industry-Sponsored Projects

Option B: Entrepreneurial Ventures

Option C: Internal Product Development
Option D: National/International Journal Paper Publication
Option E: Patent Filing Based on Project Work

By engaging in mechatronics engineering projects following this structured approach, students can gain valuable experience and contribute to the advancement of knowledge and technology in this field.

It's essential to ensure that the projects align with the intended learning objectives of the full mechatronics engineering coursework. Here are some guidelines for students as well as their **Mentors** for conducting project work:

1. Project Selection *:

- **Alignment with Course Outcomes:** Encourage students to choose projects that align with the course outcomes, emphasizing system integration, interdisciplinary collaboration, and ethical/sustainable design.
- **Problem Statement:** Require students to clearly define the engineering problem they aim to solve through the project, emphasizing the practical application of mechatronics principles.

2. Project Teams *:

- **Interdisciplinary Teams:** Promote the formation of interdisciplinary project teams, comprising students with expertise in mechanical, electronic, and computer engineering.
- **Collaboration:** Emphasize the importance of effective communication and collaboration among team members from diverse backgrounds.

3. Project Planning *:

- **Project Proposal:** Require students to submit a project proposal outlining objectives, milestones, resource requirements, and a timeline. Ensure that project plans align with project management objectives.
- **Risk Assessment:** Encourage students to identify potential risks associated with their projects and develop risk mitigation strategies.

4. Design and Integration [!]:

- **Mechanical Integration:** Emphasize the integration of mechanical components into the mechatronic system, ensuring that students select appropriate components and optimize designs.
- **Electronic Integration:** Guide students in choosing electronic components and designing circuits for data acquisition, control, and communication.

5. Programming and Control [!]:

- **Control Algorithms:** Ensure that students develop control algorithms using programming languages and control theory to meet the project's objectives.
- **Real-Time Control:** Promote the implementation of real-time control strategies for feedback and closed-loop control.

6. Testing and Validation [!]:

- **Experimental Design:** Encourage students to design experiments to systematically test and validate their mechatronic systems.
- **Data Analysis:** Teach students how to process and analyze sensor data to evaluate system performance and refine designs.

7. Documentation and Reporting[#]:

- **Documentation:** Stress the importance of maintaining comprehensive documentation throughout the project, including design specifications, schematics, code, and experimental results.
- **Reports and Presentations:** Require students to prepare written reports and deliver oral presentations to communicate project progress and outcomes effectively.

8. Ethical and Sustainable Considerations[#]:

- **Ethical Review:** Encourage students to evaluate the ethical implications of their design choices, considering safety, privacy, and societal impact.
- **Sustainability:** Emphasize sustainable design principles, such as energy efficiency and materials selection, and their integration into project designs.

9. Project Management[#]:

- **Project Timeline:** Monitor and guide students in adhering to project timelines and milestones outlined in their project proposals.

Resource Allocation: Teach students effective resource management, including budgeting, procurement, and allocation of materials and equipment.

Examination Scheme
1. Examination committee will consist of Guide, (Strictly) One Industry person and One Faculty appointed by the Institution. **2.** Well in advance soft copies of the project shall be shared with examination committee.
Presentation of Project Work
Presentation of work in the form of Project Report (s), Understanding individual capacity, Role & involvement in the project, Teamwork (Distribution of work, intrateam communication and togetherness), Participation in various contests, Publications and IPR, Manuals (Project Report, Quick reference, System, Installation guide) among other parameters. Team members with guide information shall be added at the end of the report. **Project Report** 1. The report shall be both side prints hard bound. A hardbound report shall be made after examination and examiner and guide's expected correction, before that report must be loosely bound. 2. Plagiarism check is a must, and a certificate shall be attached in the report. 3. A group activity shall be presented in the report. 4. Report copies shall be submitted in the department, one for university and one for supervisor. 5. For standardization of the project reports the following format shall be strictly followed. a. Page size: Trimmed A4 b. Top Margin: 1.00 Inches c. Bottom Margin: 1.32 Inches d. Left Margin: 1.5 Inches e. Right Margin: 1.0 Inches f. Para Text: Times New Roman 12-point font g. Line Spacing: 1.15 Lines h. Page Numbers: Right aligned at footer. Font 12 point Times New Roman i. Headings: Times New Roman, 14 Points, Boldface 10. **Certificate** 1. All students should attach a standard format of Certificate as described by the department.

2. Certificates should be awarded to project groups and not individual students of the group. Certificates should have signatures of Guide, External Examiner, Head of Department, and Director.

Index of Report

1. Title Sheet
2. Certificate (Institution)
3. Certificate (Company, if sponsored by company)
4. Acknowledgement
5. Abstract of the Project
6. List of Figures
7. List of Photographs / Plates
8. List of Tables
9. Table of Contents
10. Introduction
11. Literature Survey / Theory
12. Design / Experimentation / Fabrication / Production / Actual work carried out for the same
13. Observation Results
14. Discussion on Result and Conclusion
15. Student and Guide details. (A common photograph with project)

PR: (PR8108): PROFESSIONAL INTERNSHIP

Teaching Scheme **Practical: 12 Hrs./ Week**	Examination Scheme **Oral : 50 Marks** **Term work : 100 Marks**
Credits : 06	**Total Marks: 150 Marks**

Prerequisite Course: All subjects taught

Competency: Acquire the practical skills and industry exposure needed to design, develop, and implement innovative mechatronic systems, demonstrating a seamless integration of interdisciplinary knowledge and the ability to contribute effectively to real-world engineering projects.

Course Objectives:

Sr. No.	Course Objectives
1	Provide practical exposure for mechatronics students in industrial settings, enhancing their readiness for the professional environment.
2	Develop real-time technical and managerial skills essential for mechatronics engineering roles.
3	Stay updated on current technological advancements relevant to mechatronics.
4	Enrich classroom discussions by applying experiential learning from the industrial internship.
5	Equip students to effectively apply technical knowledge in real-world mechatronics scenarios.

Course Outcomes (COs): At the end of this course, students will be able to.:

CO. No.	COURSE OUTCOME (S)	TAXONOMY	
		Level	Descriptor
1	Demonstrate proficiency in applying theoretical knowledge to solve practical challenges in mechatronics engineering within industrial settings.	3	**Apply (Bloom's)**
2	Exhibit advanced technical and managerial skills acquired through real-time experiences, enhancing readiness for professional roles in mechatronics.	5	**Synthesis (Bloom's)**
3	Stay abreast of industry-relevant technological advancements, ensuring a contemporary understanding of mechatronics principles and practices.	4	**Analysis (Bloom's)**
4	Engage in insightful classroom discussions, integrating experiential learning from the industrial internship to bridge theory and practical application effectively.	5	**Synthesis (Bloom's)**
5	Apply acquired technical knowledge with precision and competence in diverse mechatronics scenarios, demonstrating the ability to design, implement, and troubleshoot systems in real-world contexts.	5	**Synthesis (Bloom's)**

6	Adoption of industry standards and academic integrity for report preparation.	4	**Adopt (Krathwohn's)**

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	0	0	2	0	0	0	0	0	0	1	3	3	3
CO2	0	0	3	0	3	0	0	0	0	0	3	0	3	3	3
CO3	0	0	0	0	0	0	0	0	3	3	0	0	3	3	3
CO4	0	0	0	0	0	3	0	0	0	0	0	3	3	3	3
CO5	0	0	3	0	0	0	0	3	0	0	0	0	3	3	3
CO7	0	0	0	0	0	0	0	0	0	3	3	0	3	3	3

Submission Guidelines and Assessment Methods:

a. Submission Guidelines:

- Last date to submit the internship report in standard format as described above is 20th March 2023.

b. Assessment Guidelines:

Assessment in the Professional Internship Course will be based on a combination of the following:

- **Project Evaluation:** Assessment of the quality, complexity, and functionality of the mechatronics project undertaken during the internship by Internship Review Committee.
- **Technical Reports:** Evaluation of written reports detailing project objectives, methodologies, results, and conclusions by Internship Review Committee.
- **Presentations:** Assessment of oral presentations showcasing project outcomes, emphasizing effective communication and presentation skills by Internship Review Committee.
- **Supervisor Feedback:** Input from industry supervisors to gauge the student's performance, professionalism, and contribution to the organization.
- **Mentor Feedback:** Continuous assessment by mentor. Mentor's will keep in touch with internship supervisor. Mentors will check daily status record diary.

Evaluation Criteria:

a. Technical Competence (40%):

- Quality of work on assigned projects.
- Ability to apply theoretical knowledge in practical scenarios.
- Proficiency in using relevant tools and technologies.

b. Communication Skills (20%):

- Clarity in written and oral communication.
- Ability to document work effectively.

c. Professionalism and Work Ethic (20%):

- Punctuality, reliability, and adherence to professional standards.
- Demonstration of ethical behavior and responsibility.

d. Problem-Solving and Critical Thinking (20%):

- Approach to problem-solving and innovation.
- Ability to handle unexpected challenges.

Report Format:

a. Cover Page:

- Title of the Internship Report.

- Student details (name, roll number, department, etc.).

- Name and logo of the host organization.

a. Certificate:

- Statement of originality of work.

b. Acknowledgments:

- Expression of gratitude to the host organization and mentors.

c. Abstract:

- Brief overview of the internship experience and major achievements.

c. Content:

- Table of content.

c. Notations:

- Symbols and acronyms used.

c. List of Figures:

- Figures used in report.

c. List of Tables:

- Tables used in report.

d. Introduction:

- Background information on the host organization.

- Objectives and scope of the internship.

e. Project/Work Details:

- Detailed description of the projects or tasks undertaken.

- Methodologies, tools, and technologies used.

f. Results and Discussion:

- Presentation and analysis of key findings.

- Lessons learned and insights gained.

g. Conclusion:

- Summary of the overall internship experience.

- Personal reflections and future considerations.

h. Recommendations (if applicable):

- Suggestions for improvements or further work.

i. References:

- Citations and references for any external sources used.

j. Appendices:

- Plagiarism report, charts, or data relevant to the report.

Report Printing Details:

- Report must be typed as per the following format on A4 size Executive Bond paper preferably on one side of paper with 1.5 spacing.
- The report must be printed in black color hard bound with front cover embossed.
- Number of reports (black color hard bound with front cover embossed) to prepare / submitted are 1 College copy + 1 Guide copy + each individual copy of student.
- Format of project report: Page Margins: Left Margin: 37.5 mm, Right Margin: 25 mm, Top Margin: 25 mm, Bottom Margin: 25 mm. Give page number at bottom margin at center.
- Font size & font Type:
  Chapter Number and Name - 14 Font size, Times New Roman in Capital Bold Letters.
  Main Titles (e.g. 1.1, 2.5 etc.) - 12 Font size, Times New Roman in Bold Capital Letters.
  Sub Titles (e.g. 1.1.5, 4.5.1 etc) - 12 Font size, Times New Roman in Bold Title case.
  All other matter / content -12 Font size, Times New Roman sentence case.
  Figure name - 12 Font size, Times New Roman below the figure Bold in sentence case.
  Table title - 12 font size, Bold Times New Roman sentence case above the above the table.
- No blank sheet/ page should be left in the report.
- Layout of typed content:
  Chapter Number and Name – Center of Page.
  Main Titles and Sub Titles – Justified.
  All other matter / content – Justified.

Figure & Figure name – Figure should be at Centre of page and Figure name should beat Centre of page and below the figure.

Table & Table title - Table should be at Centre of page and Table title should be at centre of page and Above the Table.

PR: (PR8108): Professional Internship

Teaching Scheme **Practical: 08 Hrs./ Week**	**Examination Scheme** **Oral : 50 Marks** **Term work : 100 Marks**
Credits : 06	**Total Marks: 150 Marks**

MC: (MC8008):

Teaching Scheme	Examination Scheme
Practical: 01 Hrs./ Week	**Audit Course- No credits**

PROFESSIONAL ELECTIVES

PE: (PE6001): INDUSTRY 4.0

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100**

Prerequisite Course: Basic concepts of Industrial management

Course Objectives:

Sr. No.	Course Objectives
1	To understand the meaning and need of this industrial revolution, how we can use it in our economic structure.
2	To understand the framework for a 4.0 industry consisting different models and layers.
3	To introduce students to robotics and its advancement over the year and current status i.r.t. industry 4.0.
4	To introduce the role of Augmented reality in the scope of industry 4.0.
5	To let students, know why is not easily applicable and sparse some light on challenges in current framework.

Course Outcomes (COs): At the end of this course, students will be able to, :

CO's	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
CO1	Understand the meaning and need of this industrial revolution, how we can use it in our economic structure	**2**	**Understand**
CO2	Understand the framework for a 4.0 industry consisting different models and layers.	**2**	**Understand**
CO3	Introduce students to robotics and its advancement over the year and current status i.r.t. industry 4.0	**3**	**Apply**
CO4	Introduce the role of Augmented reality in the scope of industry 4.0.	**3**	**Apply**
CO5	Explaining why is not easily applicable and sparse some light on challenges in current framework.	**2**	**Understand**

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	1	-	1	2	1	-	1	-	-	-
CO2	1	2	2	2	3	1	-	2	1	2	-	2	-	-	-
CO3	2	2	2		1	2	-	2	2	1	-	1	-	-	-
CO4	3	1	2	2	2	2	-	2	1	2	-	2	-	-	-
CO5	3	3	1	2	3	1	-	1	2	1	-	1	-	-	-

Course Contents

Unit No	Unit Title	No. of Hours	COs
Unit I	**Introduction to Industry 4.0 and its conceptual framework** Industry 4.0**:** Introduction, core idea of Industry 4.0, origin concept of industry 4.0, Industry 4.0 production system, current state of industry 4.0, Technologies, how is India preparing for Industry 4.0? Framework: Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.	08hrs	CO1
Unit II	**Technological Roadmap to Industry 4.0** Introduction, Proposed Framework for Technology Roadmap, Internet of Things (IoT), Industrial Internet of Things (IIoT) & Internet of Services. - Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics	06 hrs.	CO2
Unit III	**Advances in Robotics in the Era of Industry 4.0** Introduction, Recent Technological Components of robots Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly	06 hrs	CO3
Unit IV	**The Role of Augmented Reality in the Age of Industry 4.0** Introduction, AR Hardware and Software Technology, Industrial Applications of AR.	08 hrs	CO4
Unit V	**Obstacles and Framework Conditions for Industry 4.0** Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infrastructure, state support, legal framework, protection of corporate data, liability, handling personal data	08 Hrs	CO5

Textbooks:

1. Alp Ustundag and Emre Cevikcan,"Industry 4.0: Managing Digital Transformation".
2. Bartodziej, Christoph Jan, "The Concept Industry 4.0".
3. Klaus Schwab, "The Fourth Industrial Revolution".
4. Christian Schröder, "The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".
5. DeFatta D J, Lucas J G and Hodgkiss W S, "Digital Signal Processing", J Wiley and Sons, Singapore, 1988

Reference Books:

1. Alp Ustundag and Emre Cevikcan,"Industry 4.0: Managing the Digital Transformation".
2. Bartodziej, Christoph Jan,"The Concept Industry 4.0".
3. Klaus Schwab,"The Fourth Industrial Revolution".
4. Christian Schröder ,"The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".
5. DeFatta D J, Lucas J G and Hodgkiss W S, "Digital Signal Processing", J Wiley and Sons, Singapore, 1988

E-Resources: https://nptel.ac.in/courses/106105195

PE: (PE6101): INDUSTRY 4.0 LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Term Work: 50 Mark**
Credits: 01	**Total Marks: 50 Mark**

Prerequisite Course: Programming, Analytical Approach and Industrial Automation

. No.	Course Objectives
1	Attain proficiency in Industry 4.0 principles, including FMS, robotics, and communication architecture, for practical application in modern manufacturing.
2	Acquire hands-on skills in pneumatic circuit design and gripper mechanism for robotic automation in Industry 4.0 settings.
3	Develop the ability to program using basic MELFA code for efficient pick-and-place operations in an Industry 4.0 environment.

Course Outcomes (COs): Students able to:

CO	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Apply Industry 4.0 principles to modern manufacturing, including FMS, robotics, and communication architecture.	3	Apply
2	Excel in designing pneumatic circuits and gripper mechanisms for Industry 4.0 automation.	3	Apply
3	Develop basic MELFA code proficiency for efficient pick-and-place operations in Industry 4.0.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	---	1	1	2	1	---	2	2	1	---	2		---
CO2	3	---	2	2	1	1	---	1	1	2	---	2		---
CO3	3	---	2	2	1	1	---	1	2	2	---	2		---

List of Experiments:

1. Learn and understand the framework of Industry 4.0 using FMS system.
2. Basics of Robotics and its Industrial applications.
3. Understand and learn about communication architecture in FMS system.
4. Pneumatic circuit and mechanism of gripper in R.A.
5. Basic MELFA code for pick and place working with a PLC microcontroller.

PE: (PE6002): AUTOMOTIVE MECHATRONICS

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100**

Prerequisite Course: Engineering Physics, Basic Mechanical Engineering

Course Objectives:

Sr. No.	Course Objectives
1	To provide fundamental understanding of basic components of automobile.
2	To provide knowledge of sensors and actuators used in automotive.
3	To provide in depth understanding of engine management, warning, control, and safety systems.
4	To provide the state of the art knowledge about the recent development in automobile technology.

Course Outcomes (COs): At the end of this course, students will be able to, :

No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To demonstrate the knowledge of basic components of automobile system.	2	Understand
2	To study the various sensors used in automotive with their working and application.	3	Apply
3	To explore the engine management systems and warning systems of automotive.	4	Analyze
4	To illustrate the application of control system and safety systems in automotive.	4	Analyze
5	To do the state-of-the-art literature survey of the recent development in automobile system.	4	Analyze
6	To apply the knowledge of automobile, control, and safety systems to develop driverless car.	3	Apply
7	To prepare CIA report following the ethics to maintain dignity and integrity.	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**2**	**3**	**1**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**		
CO2	**2**	**3**	**1**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**3**
CO3	**2**	**3**	**1**	**1**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**3**
CO4	**2**	**3**	**1**	**1**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**3**

CO5	2	3	1	1	3	3	3	0	0	0	0	3	3	3
CO6	3	3	3	3	3	3	3	3	3	1	3	3	3	3
CO7	3	3	3	3	3	3	3	3	3	3	3	3	-	-

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Automobile Fundamentals:** Introduction to Automotive Mechatronics, Definition of Automobile, Major Components, Block Diagram, Petrol Engine, Diesel Engine, Components of IC Engine, Transmission System, Steering System, Colling and Lubrication System, and their Main Components, Suspension System, Leaf Springs, Fuel Ingestion and Ignition System, and Automobile Battery and its Types.	08	1
II	**Sensors and Actuators:** Sensors and Actuators, Principle, Construction and Working of Different Types of Sensors and Actuators. Air Flow Rate, Engine Speed, Engine Crankshaft, Throttle, Pressure, Temperature, Knock, etc.	08	2
III	**Engine Management and Warning System:** Electronic Engine Management System, Automobile Warning Systems. Brake Actuators, Oil Pressure, Engine Overheat, Air Pressure, Speed, etc.	08	3
IV	**Automotive Control and Safety System:** Automotive Motion Control System, Power Train Control System, Automobile Safety Systems, Cruise Control, ABS, Electronic Suspension, Traction, etc.	08	4
V	**Recent Trends:** Different Types of Modern Engines, Electric Vehicles, Hybrid Vehicles, Vehicle Intelligence	08	5

Textbooks:

1. Kirpal Singh, Automobile Engineering Vol-I & II, Standard Publishers, New Delhi

Reference Books:

1. GBS Narang, Automobile Engineering, Khanna Publishers, Delhi
2. William B Ribben, Understanding Automotive Electronics, Elsevier
3. AK Babu, Automotive Electrical and Electronics, Khanna Publishers, Delhi

E-Resources: https://www.youtube.com/playlist?list=PLyqSpQzTE6M9G2SNxKfsVEjcM9MlJau4F

PE: (PE6102): AUTOMOTIVE MECHATRONICS LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Term Work: 50 Mark**
Credits: 01	**Total Marks: 50 Mark**

Prerequisite Course: Engineering Physics, Basic Mechanical Engineering

Sr. No.	Course Objectives
1	Students will learn about automobile basic structure.
2	Students will learn about various sensors used in automobiles.
3	Students will be able to diagnose faults in automotive systems.

Course Outcomes (COs): At the end of this course, students will be able to, :

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To understand the basic automobile fundamentals and identify various parts, sensors and actuators used.	3	Apply
2	To perform fault diagnosis of sensors, actuators, control, management, warning, and safety system of vehicle	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**2**	**3**	**1**	**1**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**3**	**3**	**3**
CO2	**2**	**3**	**1**	**1**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**3**	**3**	**3**

List of Experiments: Laboratory work

1. To study and identify the different types of chassis used in automotive (ladder, tubular, etc.)
2. To study the classification of vehicles and to identify different types of cars (Saden, Hatchback, Station Wagon, etc.).
3. To study and identify the main components of an automotive (engine, steering system, braking system, transmission system, and control, warning, and safety systems).
4. To study the working of clutch and to repair a faulty clutch.
5. To study and identify main components in a petrol engine.
6. To study and identify various sensors used in a petrol engine.
7. To study about different types of OBD tools (OBD I and OBD II).
8. To detect faults in a Petrol engine using OBD tools.

PE: (PE6003): TOTAL QUALITY MANAGEMENT

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 03	**Total Marks: 100**

Prerequisite Course: Basic concepts of Industrial management

Course Objectives:

Sr. No.	Course Objectives
1	Identify and explain the basic concepts in Total Quality Management (TQM)
2	Able to differentiate between product quality characteristics and service quality characteristics
3	List the key steps in the control of quality
4	Distinguish between quality of design and quality of conformance to design
5	Explain the process of planning for quality
6	Explain the system of documentation, implementation, and assessment of quality

Course Outcomes (COs): At the end of this course, students will be able to, :

O. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To Understand the basic concepts in TQM	2	Understand
2	Able to differentiate product and service quality characteristics	2	Understand
3	Understand quality of design and quality of conformance.	2	Understand
4	Able to explain process of planning for quality	3	Apply
5	Able to explain specific tools and techniques for quality improvement	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	1	-	1	2	1	-	1	-	-	-
CO2	1	2	2	2	3	1	-	2	1	2	-	2	-	-	-
CO3	2	2	2		1	2	-	2	2	1	-	1	-	-	-
CO4	3	1	2	2	2	2	-	2	1	2	-	2	-	-	-
CO5	3	3	1	2	3	1	-	1	2	1	-	1	-	-	-

Course Contents

Unit No	Unit Title	No. of Hours	COs
Unit I	**Basics of Total Quality Management** Components of quality, Total quality management approach, Innovation, design and improvement, Product quality characteristics and service quality characteristics, Quality parameters and specific dimensions of quality, planning for quality- Flowcharting, Detailed flow process charts and flow diagrams, Planning for just-in-time (JIT) management, System design and contents, System documentation, implementation, and assessment.	08hrs	CO1
Unit II	**TQM Tools and the Improvement Cycle** Measurement of quality, Costs of quality, Tools and techniques for quality improvement, Statistical process control, Quality improvement techniques in service industries, Specific techniques for design, reliability, maintenance, and process improvement	06 hrs	CO2
Unit III	**Conformance and Non-conformance to Quality Standards** Quality of design, Quality of conformance to design, Control of non-conforming products. identifying and classifying non-conformance. documenting non-conforming products. reinspection of repaired and reworked products, Corrective and preventive action	06 hrs	CO3
Unit IV	**The Quality Organization Within an Organisation** People and the organizational structure, Responsibilities and performance management, the relationship between the quality organization and top management, Culture change through teamwork for quality improvement, Implementing teamwork for quality improvement	08 hrs	CO4
Unit V	**Control of Quality Records** Compilation and indexing of quality records, Storage and maintenance of quality records, Procedures related to quality records, Authentication of quality records, Internal Quality Audits : Scope of requirements and audit procedures, the audit Programme and planning of quality audits, verifying compliance with planned arrangements, Determining the effectiveness of the system, Reporting the results of quality audits	08 Hrs	CO5

Textbooks:

1. Dale H. Besterfiled, Carol B. Michna, Glen H. Basterfield, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002

Reference Books:

1. Mitra, A. (2016). Fundamentals of quality control and improvement. John Wiley & Sons.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
4. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

E-Resources :

1. https://onlinecourses.nptel.ac.in/noc20_mg34/preview

PE: (PE6103): TOTAL QUALITY MANAGEMENT

Teaching Scheme	Examination Scheme
Practical 02 Hrs. / Week	**Termwork : 50 Marks**
Credits: 02	**Total Marks: 50 Marks**

Prerequisite Course: Industrial Management, Statistics

Course Objectives (CO):

. No.	Course Objectives
1	Develop a comprehensive understanding of the fundamental principles and concepts of Total Quality Management (TQM), including its history, evolution, and the philosophy behind it. Gain insights into how TQM can enhance the overall quality and performance of an organization.
2	Acquire practical skills in applying various TQM tools and techniques, such as Process Mapping, Kaizen, Six Sigma, and Lean, to identify and eliminate defects, optimize processes, and enhance overall operational efficiency. Learn how to use these tools effectively in real-world industrial settings.
3	Explore the relationship between TQM and other Quality Management Systems (QMS), such as ISO 9001. Understand how TQM principles can be integrated with existing quality management practices and systems to achieve a holistic approach to quality improvement.

Course Outcomes (COs): Student will

CO's	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Demonstrate proficiency in applying TQM tools and techniques to identify, analyse, and resolve quality-related issues in industrial settings, resulting in improved processes and products.	2,3	Understand and Apply
2	Understand how to seamlessly integrate TQM principles with existing Quality Management Systems (QMS) to create a synergistic approach that enhances overall quality and organizational performance	3	Apply
3	Develop the skills and knowledge required to conduct comprehensive quality audits within an organization, employing industry-standard processes and techniques to ensure compliance with quality standards and certifications	3	Apply
4	Excel in preparing comprehensive reports in accordance with industry standards and a strict code of ethics. They will demonstrate the ability to document quality improvement processes, findings from audits, and the outcomes of TQM initiatives accurately and transparently, ensuring the highest level of professionalism and integrity in their documentation practices.	2	Understand and apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	3	2	2	2	0	0	0	0	0	0	2		
CO2	3	3	1	2	2	0	0	0	0	1	0	0		
CO3	3	3	1	1	2	0	0	0	0	1	0	0	1	
CO4	2	1	0	0	0	0	1	0	2	2	1	0		

List of Activities: Each student should select one topic and select a specific industry/ organization as the focus of their report.

Prepare at least one case study for each topic applicable to your choice of industry.

1. Importance of Quality Assurance and Control in Industrial Management
2. Implementation of Quality Standards and Certifications (ISO, QS, AS)
3. Process and Techniques for Quality Audits in an Organization
4. Application of Quality Control Techniques: SPC, Pareto Charts, Fishbone Diagrams
5. Effective Inspection and Testing Techniques for Quality Assurance
6. Total Productive Maintenance (TPM) and Its Role in Industrial Management
7. Strategies for Successful TPM Implementation in an Organization
8. Maintenance Strategies: Preventive, Predictive, and Corrective Maintenance
9. Maintenance Planning and Scheduling for Optimal Equipment Performance
10. Significance of Continuous Improvement in Industrial Management
11. Kaizen Philosophy and Methodology for Continuous Improvement
12. Total Quality Management (TQM) and Its Relationship with Other Quality Management Systems
13. Implementation and Certification Process of a Quality Management System (QMS)

List of Activities: Each student should select one topic and select a specific industry/ organization as the focus of their report.

Prepare at least one case study for each topic applicable to your choice of industry.

1. Importance of Quality Assurance and Control in Industrial Management
2. Implementation of Quality Standards and Certifications (ISO, QS, AS)
3. Process and Techniques for Quality Audits in an Organization
4. Application of Quality Control Techniques: SPC, Pareto Charts, Fishbone Diagrams
5. Effective Inspection and Testing Techniques for Quality Assurance
6. Total Productive Maintenance (TPM) and Its Role in Industrial Management
7. Strategies for Successful TPM Implementation in an Organization
8. Maintenance Strategies: Preventive, Predictive, and Corrective Maintenance
9. Maintenance Planning and Scheduling for Optimal Equipment Performance
10. Significance of Continuous Improvement in Industrial Management
11. Kaizen Philosophy and Methodology for Continuous Improvement
12. Total Quality Management (TQM) and Its Relationship with Other Quality Management Systems
13. Implementation and Certification Process of a Quality Management System (QMS)

PE: (PE7004): DRONE TECHNOLOGY

Teaching Scheme **Lectures: 03 Hrs. / Week**	**Examination Scheme** **CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits : 03	**Total Marks: 100**

Competency: Design and assembly of drone for specified application.

Prerequisite Course: -

Course Objectives:

Sr. No.	Course Objectives
1	To gain basic knowledge about the drones and its classification
2	To acquaint knowledge for the selection and design of various components of drone.
3	To understand different sensors, radio control system and their contribution for successful flight operation.
4	To acquire knowledge about DGCA guidelines for drone flying in India.
5	To learn real world applications and future scope for drones.

Course Outcomes (COs): At the end of this course, students will be able to, :

No.	COURSE OUTCOME (S)	TAXONOMY	
		Level	Descriptor
1	Classify and compare different drones based on various criteria and select appropriate type of drone for specific applications.	2	**Understand (BLOOM'S)**
2	Design, develop and selection of different components of drone for specified type of drone	3	**Apply (BLOOM'S)**
3	Selection of sensors and flight controller for specific applications using knowledge for successful operation of drone.	3	**Apply (BLOOM'S)**
4	Use of DGCA rules and regulations for drones for flying, complete all necessary documentations and upload it on digital sky platform	3	**Apply (BLOOM'S)**
5	Use of drones for different real world applications.	3	**Apply (BLOOM'S)**
6	To manufacture the drone for given application.	4	**Precision (Dave's)**
7	To practice DGCA regulations and academic integrity.	3	**Valuing (Krathwohl's)**

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	1	1	1	2	0	1	0	2	0	3	1	**0**	**0**
CO2	2	2	2	2	1	2	1	1	0	3	0	3	**1**	**0**	**0**
CO3	1	1	2	0	1	2	1	1	0	2	0	2	**1**	**0**	**0**
CO4	0	0	0	0	0	3	1	3	0	0	0	1	**0**	**0**	**0**
CO5	0	0	0	0	1	2	0	1	0	2	2	3	**1**	**0**	**1**
CO6	3	2	3	3	1	2	2	3	3	3	2	3	**1**	**0**	**1**
CO7	0	0	0	0	0	3	1	3	0	0	0	1	**1**	**0**	**0**

Course Contents

Unit No	Unit Title	No.of Hours	Cos
I	**Unit- I Basics of Drone** Introduction, Historical aspects of Drone technology, Types of Drones and their classification, Definitions, and terminologies relevant to Drone technology Applications of drones, basic operations of drones, components in drones , drone payloads, accessories. Flight modes in drones.	08	1
II	**Unit-II Design of Drone** Drone aerodynamics, Selection of type of drones for applications, Design of chassis, applications and uses of drone frame & drone propeller	08	2

	materials, design parameters for propellers, Selection of motor, battery, and different Sensors.		
III	**Unit-III Drone Electronics** Sensors: Wi fi devices, RADAR , GPS receiver, Gyro sensor, Image sensor, Chemical sensor. Cameras in drones and selection criteria of camera for different range. Barometers, Accelerometer, Magnetometer, remote control for drone. Radio Control System: Introduction of radio control system, Controllers, Transmitter and Receiver, Flight Controllers, Electronic Speed Controller.	06	3
IV	**Unit-IV Maintenance, safety Guidelines and Rules and Regulations** UAV maintenance and documentation, Method of UAV inspection, charging the battery. Maintenance resources and standards, Guidelines mention by DGCA. Digital Sky Platform, Documentation required for drone like logbook, maintenance book, Battery charging records etc.	08	4
V	**Unit-V Applications of drone** Real World Applications, Case Studies include Photometry, Remote Sensing, Agricultural, Defense, Disaster Management, Future Scope for drones use in swarms, Drone in precision farming etc.	06	5

Textbooks:

1. M. LaFay, Building Drones for Dummies, John Wiley & Sons, Inc., n.d.
2. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
3. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
4. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
5. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998
6. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics.
7. E. Tooley, Practical Drones: Building, Programming, and Applications, Apress, 2021.
8. D. Levy, Drone Programming: A Guide to Code Your Own Drones, Packt Publishing, n.d.
9. S. K. Kopparthy, Drone Technology: Theory and Practice, Springer, 2020.
10. P. Horowitz and W. Hill, The Art of Electronics, Cambridge University Press, 2015.
11. K. Sundar and R. V. Rajakumar, Multicopters: Principles and Applications, Springer, 2021.
12. DGCA rules and regulation Aug 2021.

Reference Books:

1. D. Saxby, Drone Aerial Photography and Video: Techniques and Stories from the Field, Cengage Learning, 2018.
2. D. McLeod, Getting Started with Drone: How to Build, Fly, and Program Your Own Drone, Apress, 2019.
3. M. A. Banks, Building and Flying Electric Model Aircraft, O'Reilly Media, Inc., 2014.
4. G. C. Camara Leal, Flying Robots: An Introduction to Autonomous Aerospace Systems, Springer, 2017.

E-Resources:

1. https://www.udemy.com/course/drone-mastering-all-its-components
2. https://www.udemy.com/course/drone-programming-with-python-face-recognition-tracking
3. www.asteria.co.in
4. www.kisspng.com
5. www.droneaviation.com
6. www.dji.com
7. www.aerosociety.com

PE: (PE7104): DRONE TECHNOLOGY LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Term work : 50 Mark**
Credits : 01	**Total Marks: 50 Mark**

Prerequisite Course: -

Sr. No.	Course Objectives
1	To study design of different mechanical components used drone.
2	To understand additive manufacturing process for manufacturing of drone components.
3	To learn ESC and flight controller used in drones.
4	To develop skills for complete assembly of drone
5	To maintain documentary of drone as per DGCA requirement

Course Outcomes (COs): At the end of this course, students will be able to, :

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To understand design of drone chassis and other mechanical components.	2	Understand
2	To understand manufacturing of drone components using additive manufacturing	2	Understand
3	To learn electronics speed controller and different types of flight controller used in drones for various applications	2	Understand
4	To acquaint knowledge of drone assembly and apply that knowledge for development of functional drone for given application	3	Apply
5	To learn different documentary required for use of drone in India and prepare sample documents for one of the drones	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	2	1	1	1	3	0	3	**1**	**0**	**0**
CO2	0	0	0	1	3	2	1	1	3	2	2	2	1	0	0
CO3	1	1	2	0	1	2	1	1	1	2	0	2	**1**	**0**	**0**
CO4	3	2	3	3	1	2	2	3	3	3	2	3	**1**	**1**	**1**
CO5	0	0	0	0	0	3	1	3	1	0	0	1	**0**	**0**	**0**

List of Experiments: Laboratory work

1. To study and sketch various frame structure viz quadcopter frame (plus shape, cross shape and H-shape),hexacopter frame (hexa+ and hexa S) using any 2D or 3D modelling software.
2. To develop the Chassis of an unmanned aerial vehicle using 3D printing process.
3. Study of ESC and Flight controllers used in Drones.
4. Study of different types of payloads used in drones for various applications.
5. Assembling of Drone for given application
6. Study of typical maintenance task for Drone.
7. Study of documentation required for drone as per the rules and regulation of DGCA.

CIA Activity

1. To design and develop drone for applications.
    a) Agriculture
    b) Defence

PE:(PE7005): ADDITIVE MANUFACTURING

Teaching Scheme Lectures: 03 Hrs. / Week	Examination Scheme CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 03	Total Marks: 100

Prerequisite Course: Basic Mechanical Engineering, Manufacturing Technology, Solid Modelling, Strength of Materials, Design of Machine Elements

Competency: This subject enables students to acquire knowledge of additive manufacturing technologies and design and manufacture of functional components using 3D printing machines.

Course Objectives:

Sr. No.	Course Objectives
1	To explain the concept of additive manufacturing and its importance in modern product development.
2	To compare various additive manufacturing technologies and their capabilities.
3	To evaluate the material science aspects of additive manufacturing and its impact on part quality.
4	To identify and apply appropriate post-processing techniques to improve the properties of additive manufacturing parts.
5	To utilize CAD modelling and AM software to design parts suitable for 3D printing.

Course Outcomes (COs): At the end of this course, students will be able to:

No.	COURSE OUTCOME (S)	TAXONOMY	
		Level	Descriptor
1	Understand the principles and significance of additive manufacturing processes in prototyping and functional part fabrication.	2	**Understand**
2	Differentiate between additive manufacturing methods based on materials, energy sources, costs, and limitations.	3	Apply
3	Study effects of process parameters on (mechanical characterization of 3D printed parts) material consolidation and solidification rates in FDM, SLS, and 3D printing technologies.	3	**Apply**
4	Design a 3D part and demonstrate proficiency in using slicing, part orientation, and support generation for additive manufacturing of complex geometries.	3	**Apply**
5	Apply heat treatment and micro-finishing methods to improve mechanical properties and surface finish of additively manufactured components.	3	**Apply**
6	Apply the knowledge of Additive Manufacturing to precisely manufacture the components for a given application.	3	**Precision (Dave's)**
7	Adoption of industry standards and academic integrity for report preparation.	4	**Adopt (Krathwohn's)**

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	2	0	1	2	2	1	3	3	0	3	0	1	3
CO2	2	0	2	0	0	2	2	1	3	3	0	3	0	1	3
CO3	3	2	2	2	1	3	2	1	3	3	0	3	0	1	3
CO4	3	2	3	3	3	3	2	1	3	3	0	3	0	1	3
CO5	2	2	2	3	1	3	2	1	3	3	0	3	0	1	3
CO6	2	3	2	3	1	2	2	1	3	3	1	3	0	1	3
CO7	0	0	0	0	0	0	0	0	3	3	0	0	0	0	3

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Introduction to Additive Manufacturing:** Basic principles of AM, Importance of Additive Manufacturing in various sectors, including product development, biomedical, space applications.	06	1
II	**Classification of additive manufacturing processes:** common additive manufacturing technologies such as **Vat Photopolymerization, Material Extrusion, Binder Jetting, Material Jetting, Powder Bed Fusion, Direct Energy Deposition, Sheet Lamination – as per ASTM standard.** Wire Arc Additive Manufacturing (WAAM), Electro Chemical AM, and 4D Printing. Detailed examination of the capabilities, materials, costs, advantages, and limitations associated with each additive manufacturing system.	08	2
III	**Material and Process Evaluation:** Material science principles are relevant to additive manufacturing, including mechanisms of material consolidation for various AM technologies (FDM, SLS, SLM, 3D printing, jetting). Study of polymers coalescence and sintering, photopolymerization, solidification rates, and meso/macro structures in additive manufacturing. additive manufacturing of composite materials. Evaluation of process-structure relationships and structure-property relationships in additive manufacturing.	06	3
IV	**CAD in Additive Manufacturing:** Introduction to CAD modelling for 3D printing, including techniques such as 3D scanning, digitization, and data handling. Concepts of **Design for Additive Manufacturing,** Overview of AM software, data formats, and standardization practices. Slicing algorithms used in additive manufacturing, including uniform flat layer slicing and adaptive slicing. Process-path generation techniques, process-path algorithms, rasterization, and part orientation strategies. Support generation guidelines for additive manufacturing.	06	4
V	**Post-processing:** Overview of post-processing techniques for additive manufacturing parts, including heat treatment, shot peening, HIPS (High Impact Polystyrene)	06	5

	removal, and micro-finishing. Applications of additive manufacturing in various industries such as prototyping, industrial tooling, aerospace, automobile, and medical fields. Quality control and reliability considerations include identifying and mitigating defects in FDM, SLS, and SLM processes. Understanding critical process parameters like geometry, temperature, composition, and phase transformation. Numerical and experimental evaluation methods for optimizing additive manufacturing processes.		

Textbooks:

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
3. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A toolbox for prototype development", CRC Press, 2011.
4. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.

Reference Books:

5. Hilton, P.D. and Jacobs, P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press,
6. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.
7. Groover Mikell P, Fundamentals of Modern Manufacturing; 2nd Ed., 2004, 670 Gro-04
8. Milewski, J.O., 2017. Additive manufacturing of metals. Cham: Springer International Publishing.
9. Leach, R. and Carmignato, S. eds., 2020. Precision Metal Additive Manufacturing. CRC Press.

E-Resources:

5. **Fundamentals Of Additive Manufacturing Technologies**
   Prof. Sajan Kapil, Department of Mechanical Engineering IIT Guwahati
   https://archive.nptel.ac.in/courses/112/103/112103306/#
6. **Metal Additive Manufacturing**
   By Prof. J. Ramkumar, Prof. Amandeep Singh, IIT Kanpur
   https://onlinecourses.nptel.ac.in/noc22_me130/preview
7. **The Future of Manufacturing Business: Role of Additive Manufacturing**
   By Prof. R. K. Amit, Prof. U. Chandrasekhar, IIT Madras, Wipro 3D
   https://onlinecourses.nptel.ac.in/noc20_mg70/preview
8. **THE FUTURE OF MAKING | 3D PRINTING Additive manufacturing**
   https://www.autodesk.com/solutions/additive-manufacturing
9. **ASME Additive manufacturing Resources**
   https://additivemanufacturing.com/resources/
10. **Additive Manufacturing,**
    M.S. Krishnan, University of Michigan
    https://www.coursera.org/learn/additive-manufacturing-3d-printing

CIA Topics:

1. Shape and Topology optimization of Mechanical components using Additive manufacturing and cad tool.
2. Assistive technology for physically disables using 3D printing.
    - Prosthetic Hand
    - Autistic Aid
3. Study the effect of layer height and % infill on tensile strength of 3D printed specimen for PLA material.
4. Study the effect of layer height and % infill on tensile strength of 3D printed specimen for ABS material.
5. Study the effect of wall thickness and % infill on tensile strength of 3D printed specimen PLA material.
6. Study the effect of wall thickness and % infill on tensile strength of 3D printed specimen ABS material.
7. Design and 3D print sustainable fashion accessories, such as jewelry, belts, or bags, using biodegradable materials or recycled plastics.

PE: (PE7105): ADDITIVE MANUFACTURING LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Term work: 25 Marks**
Credits: 01	**Total Marks: 25 Marks**

Prerequisite Course: Fundamentals of Engineering Mechanics and Mathematics

Sr. No.	Course Objectives
1	Develop an understanding of FDM printing technology and its applications.
2	Develop proficiency in the practical aspects of FDM printing, including setup, calibration, and optimization.
3	Develop skills in post-processing and troubleshooting techniques for FDM-printed parts.
4	Foster creativity and problem-solving skills through the design and printing of functional parts.

Course Outcomes (COs): At the end of this course, students will be able to:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	Demonstrate an understanding of FDM printing principles and its significance in rapid prototyping and production.	3	Apply
2	Apply setup, calibration, and optimization techniques to achieve successful FDM prints.	3	Apply
3	Apply post-processing techniques and troubleshoot common issues to enhance the quality of FDM-printed parts.	3	Apply
4	Design and print functional parts using FDM technology, considering specific requirements and applying creative problem-solving approaches.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	2	2	3	2	2	3	3	3	1	3	3		
CO2	2	2	3	3	3	2	2	3	3	3	1	3	3	1	
CO3	3	1	2	3	3	2	2	3	3	3	1	3	3		
CO4	3	3	3	3	3	2	2	3	3	3	1	3	3	1	

List of Experiments: Laboratory work

10. Setting up the FDM printer, calibrating it, and printing a simple model to understand the basic operation of the printer.
11. Investigation of the influence of different printing parameters on the quality of printed parts to optimize the printing process.
12. Exploring different FDM materials such as ABS, PLA, TPU, and PETG to understand their properties and compatibility with the FDM printing process.
13. Modifying 3D models to ensure successful printing on an FDM printer by considering design guidelines specific to the FDM process.

14. Exploring various methods to improve the surface finish and mechanical properties of FDM-printed parts through techniques like sanding, smoothing, or chemical treatments.
15. Diagnosing and resolving common issues encountered during FDM printing, providing students with skills to troubleshoot and fix problems.
16. Project - Designing and printing functional parts using FDM technology for practical applications, emphasizing real-world problem-solving and creativity.

VIRTUAL LAB Learning:

S. No.	Experiment Name	Experiment Link(s)
1	3D Printing Virtual Simulation Lab	https://3dp-dei.vlabs.ac.in/

PE:(PE7006): MACHINE LEARNING

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits : 03	**Total Marks: 100**

Prerequisite Course: **(if any)** Data Mining, Discrete Mathematics, Database

Course Objectives:

Sr. No.	Course Objectives
1	To understand the basic concepts of Machine Learning.
2	To understand the role of Regression in Machine Learning.
3	To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning.
4	To learn different classification techniques in ML.
5	To learn different clustering techniques in ML.

Course Outcomes (COs): Students able to:

CO.No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	**Understand** the basic concepts of Machine Learning.	2	Understand
2	**Apply** different regression techniques in ML.	3	Apply
3	**Apply** Bayesian algorithm to various problems.	3	Apply
4	**Understand** different classification techniques in ML.	2	Understand
5	**Understand** different clustering techniques in ML.	2	Understand
6	**Apply** different pre-processing methods to prepare training data set for ML.	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	3	-	1	1	-	-	**2**	-		3	-	-
CO2	3	2	3	**2**	-	-	-	-	-	-	-	-	2	-	-
CO3	2	2	3	1	-	-	-	-	-	-	-	-	-	**3**	2
CO4	3	1	3	**3**	-	-	-	-	-	-	-	-	**3**	2	2
CO5	3	1	2	2	-	-	-	-	-	-	-	-	3	2	3
CO6	3	1	2	3	-	3	**2**	-	-	-	-	-	2	-	-

Course Contents

Unit No	Unit Title	No.of Hours	COs
I	**INTRODUCTION TO MACHINE LEARNING** Introduction to Machine Learning, Types of machine Learning: Supervised, Unsupervised, Semi-supervised, Reinforcement Learning, Applications of Machine Learning	08	CO1
II	**REGRESSION TECHNIQUES**	08	CO2

	Linear regression- Linear models, A bi-dimensional example, Linear Regression and higher dimensionality, Ridge, Lasso and Elastic Net, Robust regression with random sample consensus, Polynomial regression, Isotonic regression, **Logistic regression**-Linear classification, Logistic regression, Implementation and Optimizations, Stochastic gradient descendent algorithms, Finding the optimal hyper-parameters through grid search, Classification metric, ROC Curve.		
III	**SVM AND BAYESIAN TECHNIQUES** Bayes‟ Theorem, Naïve Bayes‟ Classifiers, Naïve Bayes in Scikit- learn- Bernoulli Naïve Bayes, Multinomial Naïve Bayes, and Gaussian Naïve Bayes. Support Vector Machine(SVM)- Linear Support Vector Machines, Scikit-learn implementation Linear Classification, Kernel based classification, Non-linear Examples. Controlled Support Vector Machines, Support Vector Regression.	08	CO3
IV	**CLASSIFICATION AND ENSEMBLE LEARNING** Decision Trees- Impurity measures, Feature Importance. Decision Tree Classification with Scikitlearn, Ensemble Learning-Random Forest, AdaBoost, Gradient Tree Boosting, Voting Classifier. Introduction to Meta Classifier: Concepts of Weak and eager learner, Ensemble methods, Bagging, Boosting, Random Forests.K-NN Algorithms	08	CO4
V	**CLUSTERING TECHNIQUES** Clustering Fundamentals- Basics, K-means: Finding optimal number of clusters, DBSCAN, Spectral Clustering. Evaluation methods based on Ground Truth- Homogeneity, Completeness, Adjusted Rand Index. Hierarchical Clustering, Expectation maximization clustering, Agglomerative Clustering-Dendrograms, Agglomerative clustering in Scikit- learn, Connectivity Constraints	08	CO5

Textbooks:

1. Giuseppe Bonaccorso, “Machine Learning Algorithms”, Packt Publishing Limited, ISBN10: 1785889621, ISBN-13: 978-1785889622
2. Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
3. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioners Approach”, O‟REILLY, SPD, ISBN: 978-93-5213-604-9, 2017 Edition 1st.

Reference Books:

1. Ethem Alpaydin, ―Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.
2. Stephen Marsland, ―Machine Learning: An Algorithmic Perspective, CRC Press, 2009.
3. Ethem Alpaydin, “ Introduction to Machine Learning”, PHI 2nd Edition-2013, ISBN 978- 0262-01243-0
4. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, Cambridge University Press, Edition 2012, ISBN-10: 1107422221; ISBN-13: 9781107422223
5. Tom Mitchell “Machine Learning” McGraw Hill Publication, ISBN : 0070428077 9780070428072
6. Nikhil Buduma, “Fundamentals of Deep Learning”, O‟REILLY publication, second edition 2017, ISBN: 149192561

E-Resources:

1. https://www.machinelearningbook.com/
2. https://onlinecourses.nptel.ac.in/noc22_cs97/preview
3. https://nptel.ac.in/courses/106106139

PE: (PE7106): MACHINE LEARNING LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Oral Exam: 25 Marks**
Credits : 01	**Total Marks: 25 Marks**

Prerequisite Course: Python, Mathematical Foundations for Machine Learning.

Sr. No.	Course Objectives
1	To use python to solve real world problems based on Artificial Intelligence and Machine Learning.
2	To use different python libraries suitable for machine learning.
3	To learn the evaluation of the models designed.
4	To compare results of different algorithms.
5	To use various machine learning algorithms used for classification, regression,clustering.

Course Outcomes (COs): Students able to:

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	**Use** Numpy library, Pandas, matplotlib for performing a wide variety of operations on data and visualizing the result.	3	Apply
2	**Design** different models for classification, regression, clustering applications.	3	Apply
3	**Design** a chat bot for any real-world application.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	-	-	-	-	-	-	-	-	---	2	1	1
CO2	2	2	2	1	2	-	1	-	1	-	---	2	1	2
CO3	1	2	2	1	3	1	1	1	-	1	---	2	1	1

List of Experiments: Laboratory work

Suggested List of Assignments

[Students must complete all the assignments towards the successful completion of Term. Work, where all the implementation and design assignments are compulsory]

Group A

1. Write a NumPy program to compute the cross product of two given vectors. Crosscheck your result without using Numpy.

Suppose a fruit-seller sold 20 mangoes and 10 oranges in one day for a total of $350. The next day he sold 17 mangoes and 22 oranges for $500. If the prices of the fruits remained unchanged on both the days, what was the price of one mango and one orange? Solve the given problem. using Numpy library in python.

2. Write a Python program using matplotlib to create a pie chart of gold medal

achievements of five most successful countries in 2018 Winter Olympics. Read the data. from a csv file.
3. Write a Pandas program to add leading zeros to the integer column in a panda's series and makes the length of the field to 8 digits. Use Lambda function.

4. Write a Pandas program to create
a) Datetime object for March 25, 2022.
b) Specific date and time of 9:05am.
c) Local date and time.
d) A date without time.
e) Current date.
f) Time from a datetime.
g) Current local time.

Group B

1. Write a Python program to load the iris data from a given csv file into a dataframe and print the shape of the data, type of the data and first 3 rows. Also get the number of observations, missing values, and NAN values.
2. Write a Python program to split the iris dataset into independent and dependent variables. Further using Scikit-learn to split the iris dataset into 70% train data and 30% test data. Print both datasets.
3. Train or fit the data from the above assignment into the model and calculate the accuracy of the model using the K Nearest Neighbor Algorithm.
4. Write a Python program to create a scatter plot using sepal length and petal_width to separate the Species classes.
   Develop an elementary chatbot for suggesting investment as per the customers' needs.

OPEN ELECTIVES

Open Electives I& II (MOOC- NPTEL)

OPEN ELECTIVE I: (OE8001*)

Teaching Scheme Lecture: 03 Hrs./ Week	Examination Scheme CIA : 25 Marks End Sem Exam : 75 Mark
Credits : 03	Total Marks: Marks

1. (OE8001A) :An Introduction to Artificial Intelligence

https://onlinecourses.nptel.ac.in/noc24_cs08/preview

2. (OE8001 B): Deep Learning

https://onlinecourses.nptel.ac.in/noc24_ee04/preview

3. (OE8001 C) : Reinforcement Learning

https://onlinecourses.nptel.ac.in/noc24_cs52/preview

4. (OE8001 D) : Cloud Computing

https://onlinecourses.nptel.ac.in/noc24_cs17/preview

OPEN ELECTIVE II: (OE8002*)

5. (OE8002A): Waste to Energy Conversion

https://onlinecourses.nptel.ac.in/noc24_ch29/preview

6. (OE8002B): Introduction to Refrigeration and Air-Conditioning

https://onlinecourses.nptel.ac.in/noc24_me77/preview

7. (OE8002C) : Design, Technology and Innovation

https://onlinecourses.nptel.ac.in/noc24_de08/preview

8. (OE8002D): Computer Vision and Image Processing - Fundamentals and Applications

https://onlinecourses.nptel.ac.in/noc24_ee38/preview

HONORS -COURSES

HN: (HN5001): CYBER PHYSICAL SYSTEMS

Teaching Scheme Lectures: 04 Hrs. / Week	Examination Scheme CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 04	Total Marks: 100

Prerequisite Course: Fundamentals of Engineering Mechanics and Mathematics

Course Objectives:

Sr. No.	Course Objectives
1	Understand the concepts and principles of Cyber Physical Systems, including the physical and network layer, storage layer, processing and analytic layer, application layer, and cyber physical products and digital twin.
2	Analyze and evaluate the role and impact of Cyber Physical Systems on society, economy, and environment.
3	Design and implement Cyber Physical Systems using various technologies, tools, and platforms.
4	Demonstrate critical thinking and problem-solving skills in identifying, analyzing, and resolving complex issues and challenges in Cyber Physical Systems.
5	Communicate effectively and collaboratively with peers, stakeholders, and experts in Industry 4.0
6	Develop a lifelong learning mindset and professional ethics in the field of Industry 4.0.

Course Outcomes (COs): At the end of this course, students will be able to, :

CO No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To understand and evaluate different communication protocols and networking technologies for their application in cyber physical systems.	2	Understand
2	To implement appropriate data storage solutions for different cyber physical systems and evaluate the benefits and limitations of different storage technologies.	2	Understand
3	To learn and understand various analytical techniques and algorithms to analyze and extract insights from the data generated by cyber physical systems.	3	Apply
4	To design and develop applications that can interface with the cyber physical systems and utilize the data generated by them.	3	Apply
5	To design, develop and implement digital twin models for cyber physical systems and evaluate their effectiveness in simulating real-world scenarios.	4	Analyze
6	To evaluate the performance of different cyber physical systems using appropriate metrics and techniques, and provide recommendations for improving their efficiency and reliability	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO2	3	3	-	2	2	-	-	-	-	-	-	2	3	-
CO3	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO4	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO5	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO6	3	3	2	2	-	-	-	-	-	-	-	2	3	-

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Physical Layer:** Sensors, Actuators and Transducers, Single Chip Computing Element (controllers). **Network Layer:** UART, SPI, I2C, ZigBee, Bluetooth, WAP, Wi-Fi, Cellular, Satellites and Antennas	08	1
II	**Storage Layer:** Data Storage Basics, Types of Storage devices, SAN vs NAS, Data warehouse Architecture, Servers, Local and Cloud storage.	08	2
III	**Processing and Analytic Layer:** Importance of database, tools for database, SQL, basic queries, report and graph deduction from data, dashboard visualization, real time monitoring application. Data Mining Techniques**:** Clustering, Classification and Regression to monetize the data for predictive maintenance	08	3
IV	**Application Layer:** User Interface for Consumer, Manufacturers, Operators, Managers, third party suppliers and other service providers. Some applications: - Smart Factory - Smart Building - Smart Transportation - Smart Healthcare, etc	08	4
V	**Cyber Physical Products, and Digital Twin:** Digital Twin, Case study for certain CPS based projects. Virtual and Physical systems and their integration.	08	5

Textbooks:

1. CYBER PHYSICAL SYSTEMS AND INDUSTRY 4.0: Practical Applications and Security Management, Dinesh Goyal et al., CRC Press ISBN: 978-1-77188-971-1

2. Recent advances towards Industry 4.0, Roman Szewczyk Jiri Krejsa, Spriner verlag Pubs

Reference Books:

1. Industry 4.0 for SMEs Challenges, Oppurtunities and Requirements, Dominik T. Matt, Vladimer Modriak, Helmut Zsifkovits Editors, Palgrave Macmillan, 2019
2. Internet of Things: Key Application and Protocols, Hersent Oliver, Wiley Publication
3. Introduction to Data Mining Case Studies, Gupta G K, Phi Publication
4. Handbook of Industry 4.0 and SMART Systems, Diego Galar, Pasquale Daponte, Uday Kumar, CRC Press ISBN 9781032103433.

E-Resources: **https://archive.nptel.ac.in/courses/106/105/106105241/**
https://www.edx.org/course/cyber-physical-systems-and-the-internet-of-things

HN: (HN6002): DATABASE MANAGEMENT SYSTEMS AND INFORMATION SECUIRITY IN AUTOMATION

Teaching Scheme	Examination Scheme
Lectures: 04 Hrs. / Week	**CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 04	**Total Marks: 100**

Prerequisite Course: **Basic concepts of mathematics, logical and analytical thinking, basics of computer**

Course Objectives:

Sr. No.	Course Objectives
1	Understand the fundamental concepts and principles of database management systems.
2	Explain the different types of DBMS, their architectures, and their applications in Mechatronics Engineering.
3	Design, implement, and manage databases using modern DBMS tools and techniques.
4	Analyze and evaluate the performance of databases and DBMS systems.
5	Apply critical thinking and problem-solving skills to identify and solve complex engineering problems related to DBMS.
6	Demonstrate the ability to work effectively in a team environment to design and implement databases using DBMS in real-world scenarios.
7	Communicate effectively, both orally and in writing, on the design, development, and implementation of databases using DBMS in Mechatronics Engineering.

Course Outcomes (COs): At the end of this course, students will be able to, :

CO No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To understand and evaluate different communication protocols and networking technologies for their application in cyber physical systems.	2	Understand
2	To implement appropriate data storage solutions for different cyber physical systems and evaluate the benefits and limitations of different storage technologies.	2	Understand
3	To learn and understand various analytical techniques and algorithms to analyze and extract insights from the data generated by cyber physical systems.	3	Apply
4	To design and develop applications that can interface with the cyber physical systems and utilize the data generated by them.	3	Apply
5	To design, develop and implement digital twin models for cyber physical systems and evaluate their effectiveness in simulating real-world scenarios.	4	Analyze
6	To evaluate the performance of different cyber physical systems using appropriate metrics and techniques, and provide recommendations for improving their efficiency and reliability	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO2	**3**	**3**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO3	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO4	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO5	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
CO6	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Introduction**: Characteristics and fundamental concepts of Databases, Types of Data Models and Data Modelling, Elements of Database Systems, Classification, and comparison of Database Management Systems (Regular and NoSQL Page), concurrency control, Lock based concurrency control, Time stamping methods.	08	1
II	**Structured and semi-structured data management**: Structured data, relational databases, Relational model, Functional Dependencies, normal forms, algorithms for query optimization, Semi-structured data, document-databases, semi-structured data abstraction, representation, and search.	08	2
III	**Transaction Management:** Transaction concept, transaction state, ACID properties, serializability, Recoverability, Implementation of Isolation, Testing for serializability.	08	3
IV	**Unstructured Data Management:** Unstructured text, Information retrieval systems, document retrieval and ranking, Introduction to data Mining.	08	4
V	**Big Data Management** Platforms for Big Data, algorithms for Map-Reduce & Hadoop, Platforms for Big Graphs, algorithms for large graphs.	08	5

Textbooks:

1. Database System Concepts, Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Tata McGraw Hill, 2006
2. Fundamentals of Database Systems, Elmsari and Navathe, Pearson Education 2013
3. Database Management Systems, Ramakrishnan and Gehrke, McGrawHill 2003

4. “An Introduction to Database Systems”, C.J. Date, A. Kannan, S. Swamynathan, Pearson Education, 2006

Reference Books:

1. Database Management Systems, R.P. Mahapatra, Khanna Book Publishing 2016.
2. J. D. Ullman, “Principles of Database Systems”, 2nd Ed., Galgotia Publications
3. Learning Spark: Lightning-Fast Big Data Analysis / Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia / O'Reilly Media; 1st edition / ISBN-13: 978-1449358624 / ISBN-10: 1449358624
4. Data on the Web: From Relations to Semi structured Data and XML / Serge Abiteboul, Peter Buneman, Dan Suciu / 1st Edition / ISBN-13: 978-1558606227 /
5. ISBN-10: 155860622X
6. Introduction to Information Retrieval / Christopher Manning, Prabhakar Raghavan, Hinrich Schütze / book and slides available online

E-Resources: https://nptel.ac.in/courses/112107292

HN: (HN6102): DATABASE MANAGEMENT SYSTEMS LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Term Work: 50 Mark**
Credits: 01	**Total Marks: 50 Mark**

Prerequisite Course: Programming, Analytical Approach and Engineering Mathematics III

Sr. No.	Course Objectives
1	Develop practical skills in designing and implementing database systems using popular DBMS software.
2	Gain hands-on experience in querying and manipulating data using SQL commands.
3	Apply normalization techniques to ensure database accuracy, consistency, and efficiency

Course Outcomes (COs): At the end of this course, students will be able to, :

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To understand what a database and its forms is.	3	Apply
2	Perform and understand basic operations on a structured database.	3	Apply
3	Understand the use of database in live projects	2	Understand
4	Understand and handle big data sets.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	---	1	1	2	1	---	2	2	2	---	2		---
CO2	3	---	1	1	2	1	---	2	2	2	---	2		---
CO3	3	---	1	1	2	1	---	2	2	2	---	2		---

List of Experiments: Laboratory work

1. Implement normal forms in a database.
2. Implement basic SQL commands on a database.
3. Implement information and raking using any language.
4. Implement document retrieval and ranking using any algorithm.
5. Implement Map-reduce algorithm on any big data task.

HN: (HN7003): INDUSTRIAL IoT AND INTENET OF SERVICES

Teaching Scheme	Examination Scheme
Lectures: 04 Hrs. / Week	CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 04	Total Marks: 100

Coursera

HN: (HN7103): INDUSTRIAL IoT AND INTENET OF SERVICES

Teaching Scheme	Examination Scheme
Practical : 02 Hrs. / Week	Termwork : 50 Marks
Credits: 01	Total Marks: 50 Marks

Coursera

HN: (HN8004): CYBER SECURITY IN MANUFACTURING

Teaching Scheme	Examination Scheme
Lectures: 04 Hrs. / Week	**End Sem Exam: 30 Marks** **End Sem Exam: 50 Marks** **CIA : 20 Marks**
Credits : 04	**Total Marks: 100**

Coursera Course

Link: https://www.coursera.org/learn/cyber-security-manufacturing?specialization=digital-manufacturing-design-technology

Course Content:

1. Introduction to battery manufacturing system
   The purpose of this module is to introduce you to the information security need, framework, and processes, as it applies to creating a strong and secure Digital Manufacturing and Design infrastructure.

2. Guidance on Securing manufacturing operations
   The purpose of this module is to introduce you to the various components of the digital manufacturing operation and the basic security concepts that can be used to protect these components.

3. Protecting operational technology and intellectual property
   The purpose of this module is to describe how the various operational steps of digital manufacturing – that includes - supply chain, shipping process, mobile device usage and the associated communication – can be protected, along with the Intellectual Property (IP) items that arise during digital manufacturing and design.

4. Security Breach response
   The purpose of this module is to teach you how to respond to security breaches when they happen. We will start with the threat landscape and system failures and investigate the interplay between security and reliability, which are essential for building dependable systems. The mechanism of continuous monitoring to detect security breaches, and strategies for forensics, breach response, and recovery will also be described.

HN: (HN5011): AUTOMOTIVE MACHINES AND DRIVES

Teaching Scheme Lectures: 04 Hrs. / Week	Examination Scheme CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 04	Total Marks: 100

Prerequisite Course: Engineering Physics, Basic Mechanical Engineering

Course Objectives:

Sr. No.	Course Objectives
1	To provide fundamental understanding of basic components of automobile.
2	To provide knowledge of sensors and actuators used in automotive.
3	To provide in depth understanding of engine management, warning, control, and safety systems.
4	To provide the state of the art knowledge about the recent development in automobile technology.

Course Outcomes (COs): At the end of this course, students will be able to, :

CO. No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To demonstrate the knowledge of basic components of automobile system.	2	Understand
2	To study the various sensors used in automotive with their working and application.	3	Apply
3	To explore the engine management systems and warning systems of automotive.	4	Analyze
4	To illustrate the application of control system and safety systems in automotive.	4	Analyze
5	To do the state-of-the-art literature survey of the recent development in automobile system.	4	Analyze
6	To apply the knowledge of automobile, control, and safety systems to develop driverless car.	3	Apply
7	To prepare CIA report following the ethics to maintain dignity and integrity.	3	Apply

Mapping of COs to POs & PSOs:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	1	3	0	0	0	0	0	0	3	3	0
CO2	2	3	1	1	3	0	0	0	0	0	0	3	3	0
CO3	2	3	1	1	3	3	0	0	0	0	0	3	3	0
CO4	2	3	1	1	3	3	0	0	0	0	0	3	3	0

CO5	2	3	1	1	3	3	3	0	0	0	0	3	3	0
CO6	3	3	3	3	3	3	3	3	3	1	3	3	3	3
CO7	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Course Contents

Unit No	Unit Title	No. of Hours	COs
I	**Automobile Fundamentals:** Introduction to Automotive Mechatronics, Definition of Automobile, Major Components, Block Diagram, Petrol Engine, Diesel Engine, Components of IC Engine, Transmission System, Steering System, Colling and Lubrication System, and their Main Components, Suspension System, Leaf Springs, Fuel Ingestion and Ignition System, and Automobile Battery and its Types.	08	1
II	**Sensors and Actuators:** Sensors and Actuators, Principle, Construction and Working of Different Types of Sensors and Actuators. Air Flow Rate, Engine Speed, Engine Crankshaft, Throttle, Pressure, Temperature, Knock, etc.	08	2
III	**Engine Management and Warning System:** Electronic Engine Management System, Automobile Warning Systems. Brake Actuators, Oil Pressure, Engine Overheat, Air Pressure, Speed, etc.	08	3
IV	**Automotive Control and Safety System:** Automotive Motion Control System, Power Train Control System, Automobile Safety Systems, Cruise Control, ABS, Electronic Suspension, Traction, etc.	08	4
V	**Recent Trends:** Different Types of Modern Engines, Electric Vehicles, Hybrid Vehicles, Vehicle Intelligence	08	5

Textbooks:

1. Kirpal Singh, Automobile Engineering Vol-I & II, Standard Publishers, New Delhi

Reference Books:

1. GBS Narang, Automobile Engineering, Khanna Publishers, Delhi
2. William B Ribben, Understanding Automotive Electronics, Elsevier
3. AK Babu, Automotive Electrical and Electronics, Khanna Publishers, Delhi

E-Resources: https://www.youtube.com/playlist?list=PLyqSpQzTE6M9G2SNxKfsVEjcM9MlJau4F

HN: (HN5111): AUTOMOTIVE MACHINES AND DRIVES LAB

Teaching Scheme **Practical: 02 Hrs./ Week**	Examination Scheme **Term Work: 50 Mark**
Credits: 01	**Total Marks: 50 Mark**

Prerequisite Course: Engineering Physics, Basic Mechanical Engineering

Course Objectives:

Sr. No.	Course Objectives
1	Students will learn about automobile basic structure.
2	Students will learn about various sensors used in automobiles.
3	Students will be able to diagnose faults in automotive systems.

Course Outcomes (COs): At the end of this course, students will be able to, :

CO's No.	COURSE OUTCOME (S)	BLOOM'S TAXONOMY	
		Level	Descriptor
1	To understand the basic automobile fundamentals and identify various parts, sensors and actuators used.	3	Apply
2	To perform fault diagnosis of sensors, actuators, control, management, warning, and safety system of vehicle	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**2**	**3**	**1**	**1**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**3**	**3**	**3**
CO2	**2**	**3**	**1**	**1**	**3**	**0**	**0**	**3**	**3**	**3**	**0**	**3**	**3**	**3**

List of Experiments: Laboratory work

1. To study and identify the different types of chassis used in automotive (ladder, tubular, etc.)
2. To study the classification of vehicles and to identify different types of cars (Saden, Hatchback, Station Wagon, etc.).
3. To study and identify the main components of an automotive (engine, steering system, braking system, transmission system, and control, warning, and safety systems).
4. To study the working of clutch and to repair a faulty clutch.
5. To study and identify main components in a petrol engine.
6. To study and identify various sensors used in a petrol engine.
7. To study about different types of OBD tools (OBD I and OBD II).
8. To detect faults in a Petrol engine using OBD tools.

HN: (HN7013): INTRODUCTION TO BATTERY MANAGEMET SYSTEM

Teaching Scheme Lectures: 04 Hrs. / Week	Examination Scheme CIA : 40 Marks End Sem Exam : 60 Mark
Credits: 04	Total Marks: 100

HN: (HN7113): INTRODUCTION TO BATTERY MANAGEMET SYSTEM LAB

Teaching Scheme Practical : 02 Hrs. / Week	Examination Scheme Term Work: 50 Mark
Credits: 02	Total Marks: 50 Mark

HN: (HN8014): ELECTRIC VEHICLES AND MOBILITY

Teaching Scheme **Lectures: 04 Hrs. / Week**	Examination Scheme **CIA : 40 Marks** **End Sem Exam : 60 Mark**
Credits: 04	**Total Marks: 100**

Coursera Course

Link: https://www.coursera.org/learn/electric-vehicles-mobility

Course Content:

- Understand mobility and its evolution Electric mobility and environmental impact, Economic Analysis, Electric mobility infrastructure, Electric mobility today, Electric mobility, Connected mobility and Autonomous mobility.