KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Providing value based quality education for the development of students as competent and responsible citizens.
- Contributing to the nation and beyond through research and development
- Continuously improving our services

DEPARTMENT OF MECHATRONICS ENIGNEERING

VISION

To be a centre of excellence for development and dissemination of knowledge in Mechatronics Engineering for the Nation and beyond.

MISSION

Department of Mechatronics Engineering is committed to:

MS1: Disseminate knowledge through effective teaching-learning process to develop quality Mechatronics professionals to meet the global challenges

MS2: Foster continuous learning and research by nurturing innovation and providing state-of-the art facilities

MS3: Collaborate with industries and R&D organizations to promote training and consultancy services

2020 REGULATIONS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of M.E. MECHATRONICS ENGINEERING will

PEO1: Design and develop Mechatronics solutions by integrating mechanical engineering, electronic control and robot system concepts

PEO2: Exhibit research aptitude and life-long learning in the working environment

PEO3: Solve real world needs using robots and troubleshoot industrial problems

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	3	2	3
MS2	3	3	2
MS3	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)

Engineering Post Graduates will be able to:

PO1 Independently carry out research /investigation and development work to solve practical problems

PO2 Write and present a substantial technical report/document

PO3 Identify, formulate and analyze Mechatronics engineering problems and provide solutions using modern engineering and IT tools

MAPPING OF PEOs WITH POs

PEO\PO	PO1	PO2	PO3
PEO1	3	2	3
PEO2	3	3	3
PEO3	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

CURRICULUM BREAKDOWN STRUCTURE

Summary of Credit Distribution

	Semester				Total number of credits	Curriculum Content (% of total number of credits of the program)
	I	II	III	IV		
FC(MATHS)	**4**	**-**	**-**	**-**	**4**	**5.55**
PC	15	15			30	**41.67**
PE	3	6	3	6	18	**25.00**
EC		**2**	**9**	**9**	**20**	**27.78**
Semester wise Total	22	23	12	15	**72**	**100.00**

Category	Abbreviation
Lecture hours per week	**L**
Tutorial hours per week	**T**
Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week	**P**
Credits	**C**

CATEGORISATION OF COURSES								
FOUNDATION COURSES (FC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream***
1.	20AMT12	Advanced Mathematics	3	1	0	4	1	GE
Total Credits to be earned						4		
PROFESSIONAL CORE (PC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
1.	20MMT11 /20MMT12	Bridge Course Electronics (or) Bridge Course Mechanical	3	1	0	4	1	AE
2.	20MMT13	Control System Engineering	3	0	0	3	1	AE
3.	20MMT14	Sensors and IoT	3	0	0	3	1	AE
4.	20GET11	Introduction to Research	2	1	0	3	1	GE
5.	20MML11	Control System Engineering Laboratory	0	0	2	1	1	AE
6.	20MML12	Sensors and IoT Laboratory	0	0	2	1	1	AE
7.	20MMC21	Fluid power system	3	0	2	4	2	PS
8.	20MMC22	Robot kinematics and dynamics	3	0	2	4	2	AS
9.	20MMT21	Embedded systems and control	3	0	0	3	2	AE
10.	20MMT22	Integrated Automation Controllers	3	0	0	3	2	AE
11.	20MML21	Embedded systems and PLC laboratory	0	0	2	1	2	AE
Total Credits to be earned						30		
PROFESSIONAL ELECTIVE (PE)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
		SEMESTER I						
1.	20MME01	Computer Numerically Controlled Machines	3	0	0	3	1	AE
2.	20MME02	Industrial Drives	3	0	0	3	1	AE
3.	20MME03	Metrology and Computer Aided Inspection	3	0	0	3	1	PD
		SEMESTER II						
		GROUP 1						
4.	20MME04	MEMS Design	3	0	0	3	2	PD
5.	20MME05	Virtual Instrumentation	3	0	2	4	2	AE
6.	20MME06	Factory Automation and CIM	3	0	0	3	2	AE
		GROUP 2						
7.	20MME07	Process Control Engineering	3	0	0	3	2	AE
8.	20MME08	Applied Finite Element Method	3	0	0	3	2	PD
9.	20MME09	Composite materials	3	0	0	3	2	PD
		SEMESRTER III						
10.	20MME10	Machine Tool Control and Condition Monitoring	3	0	0	3	3	PS
11.	20MME11	Industrial Data Communication	3	0	0	3	3	AE
12.	20MME12	Artificial Intelligence and Machine Learning	3	0	0	3	3	AS
		SEMESTER IV						
		GROUP 1						
13.	20MME13	Machine Vision System	3	0	2	4	4	AE

14.	20MME14	Product Design and Development	3	0	0	3	4	PD
15.	20MME15	Drone technology	3	0	0	3	4	AS
		GROUP 2						
16.	20MME16	Autonomous Mobile robotics	3	0	2	4	4	AS
17.	20MME17	Additive Manufacturing	3	0	0	3	4	PS
18.	20GET13	Innovation and business model development	3	0	0	3	4	GE
EMPLOYABILITY ENHANCEMENT COURSES (EC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
1.	20MMP21	Innovative Project	0	0	4	2	2	NA
2.	20MMP31	Project Work Phase I	0	0	18	9	3	NA
3.	20MMP41	Project Work Phase II	0	0	18	9	4	NA
Total Credits to be earned						20		

***** Domain/Stream Abbreviations: AE- Automation Engineering, , AS – Autonomous Systems, PD – Product Design, PS – Production System, GE – General Engineering

KEC R2020: SCHEDULING OF COURSES – M.E. (MECHATRONICS ENGINEERING)

Semester	Theory/ Theory cum Practical / Practical								Internship & Projects	Online/ VACs	Special Courses	Credits
	1	2	3	4	5	6	7	8	9	10	11	
I	20AMT12 Advanced Mathematics (PC-3-1-0-4)	20MMT11/ 20MMT12 Bridge Course Electronics (or) Bridge Course Mechanical (PC-3-1-0-4)	20GET11 Introduction to Research (PC-2-1-0-3)	20MMT13 Control System Engineering (PC-3-0-0-3)	20MMT14 Sensors and IoT (PC-3-0-0-3)	Elective-I (Professional) (PC-3-0-0-3)	20MML11 Sensors and IoT laboratory (PC-0-0-3-1)	20MML12 Control System Engineering Laboratory (PC-0-0-3-1)				22
II	20MMC21 Fluid Power System (PC-3-0-2-4)	20MMC22 Robot kinematics and dynamics (PC-3-0-2-4)	20MMT21 Embedded systems and control (PC-3-0-0-3)	20MMT22 Integrated Automation Controllers (PC-3-0-0-3)	Elective-II (Professional) (PC-3-0-0-3)	Elective-III (Professional) (PC-3-0-0-3)	20MML21 Embedded Systems and PLC Laboratory (PC-0-0-3-1)		20MMP21 Innovative Project			23
III	Elective-IV (Professional) (PC-3-0-0-3)								20MMP31 Project Work – Phase I			12
IV	Elective-V (Professional) (PC-3-0-0-3)	Elective-VI (Professional) (PC-3-0-0-3)							20MMP41 Project Work – Phase II			15

Total Credits: 72

MAPPING OF COURSE WITH PROGRAM OUTCOMES

Sem.	Course Code	Course Title	PO1	PO2	PO3
I	20MMT11/ 20MMT12	Bridge Course Electronics (or) Bridge Course Mechanical	✓	✓	✓
I	20AMT12	Advanced Mathematics for Mechatronics	✓		
I	20GET11	Introduction to Research	✓	✓	✓
I	20MMT13	Control System Engineering	✓	✓	✓
I	20MMT14	Sensors and IoT	✓	✓	✓
I	20MML11	Control System Engineering Laboratory	✓	✓	✓
I	20MML12	Sensors and IoT Laboratory	✓	✓	✓
II	20MMC21	Fluid power system	✓	✓	✓
II	20MMC22	Robot kinematics and dynamics	✓	✓	✓
II	20MMT21	Embedded systems and control	✓	✓	✓
II	20MMT22	Integrated Automation Controllers	✓	✓	✓
II	20MML21	Embedded systems and PLC laboratory	✓	✓	✓
I	20MME01	Computer Numerically Controlled Machines	✓	✓	✓
I	20MME02	Industrial Drives	✓	✓	✓
I	20MME03	Metrology and Computer Aided Inspection	✓	✓	✓
II	20MME04	MEMS Design	✓	✓	✓
II	20MME05	Virtual Instrumentation	✓	✓	✓
II	20MME06	Factory Automation and CIM	✓	✓	✓
II	20MME07	Process Control Engineering	✓	✓	✓
II	20MME08	Applied Finite Element Method	✓	✓	✓
II	20MME09	Composite materials	✓	✓	✓
III	20MME10	Machine Tool Control and Condition Monitoring	✓	✓	✓
III	20MME11	Industrial Data Communication	✓	✓	✓
III	20MME12	Artificial Intelligence and Machine Learning	✓	✓	✓
IV	20MME13	Machine Vision System	✓	✓	✓
IV	20MME14	Product Design and Development	✓	✓	✓
IV	20MME15	Drone technology	✓	✓	✓
IV	20MME16	Autonomous Mobile robotics	✓	✓	✓
IV	20MME17	Additive Manufacturing	✓	✓	✓
IV	20GET13	Innovation and Business Model Development	✓	✓	✓

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M.E. DEGREE IN MECHATRONICS ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2020-21 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory								
20AMT12	Advanced Mathematics	3	1	2	4	50	50	100	FC
20GET11	Introduction to Research	2	1	0	3	50	50	100	PC
20MMT11/ 20MMT12	Bridge Course Electronics (or) Bridge Course Mechanical	3	1	0	4	50	50	100	PC
20MMT13	Control System Engineering	3	0	0	3	50	50	100	PC
20MMT14	Sensors and IoT	3	0	0	3	50	50	100	PC
	Professional Elective 1	3	0	0	3	50	50	100	PC
	Practical								
20MML11	Control System Engineering Laboratory	0	0	2	1	100	0	100	PC
20MML12	Sensors and IoT Laboratory	0	0	2	1	100	0	100	PC
	Total				**22**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN MECHATRONICS ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2020-21 onwards)

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory								
20MMC21	Fluid Power System	3	0	2	4	50	50	100	PC
20MMC22	Robot Kinematics and Dynamics	3	0	2	4	50	50	100	PC
20MMT21	Embedded Systems and Control	3	0	0	3	50	50	100	PC
20MMT22	Integrated Automation Controllers	3	0	0	3	50	50	100	PC
	Professional Elective – II	3	0	0	3	50	50	100	PE
	Professional Elective – III	3	0	0	3	50	50	100	PE
	Practical / Project								
20MML21	Embedded systems and PLC laboratory	0	0	3	1	100	0	100	PC
20MMP21	Innovative Project	0	0	4	2	100	0	100	EC
	Total				**23**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN MECHATRONICS ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2020-21 onwards)

SEMESTER – III

	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Practical / Project								
	Professional Elective – IV/ Online Course				3	100	0	100	PE
20MMP31	Internship cum Project work				9	50	50	100	EC
	Total				**12**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN MECHATRONICS ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2020-21 onwards)

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
	Professional Elective V	3	0	0	3	50	50	100	PE
	Professional Elective VI	3	0	0	3	50	50	100	PE
	Practical								
20MMP41	Project work Phase II	0	0	18	9	50	50	100	EC
	Total				**15**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

Total Credits: 72

LIST OF PROFESSIONAL ELECTIVES						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
	SEMESTER I					
20MME01	Computer Numerically Controlled Machines	3	0	0	3	PE
20MME02	Industrial Drives	3	0	0	3	PE
20MME03	Metrology and Computer Aided Inspection	3	0	0	3	PE
	SEMESTER II					
	GROUP 1					
20MME04	MEMS Design	3	0	0	3	PE
20MME05	Virtual Instrumentation	3	0	2	4	PE
20MME06	Factory Automation and CIM	3	0	0	3	PE
	GROUP 2					
20MME07	Process Control Engineering	3	0	0	3	PE
20MME08	Applied Finite Element Method	3	0	0	3	PE
20MME09	Composite materials	3	0	0	3	PE
	SEMESRTER III					
20MME10	Machine Tool Control and Condition Monitoring	3	0	0	3	PE
20MME11	Industrial Data Communication	3	0	0	3	PE
20MME12	Artificial Intelligence and Machine Learning	3	0	0	3	PE
	SEMESTER IV					
	GROUP 1					
20MME13	Machine Vision System	3	0	2	4	PE
20MME14	Product Design and Development	3	0	0	3	PE
20MME15	Drone technology	3	0	0	3	PE
	GROUP 2					
20MME16	Autonomous Mobile robotics	3	0	2	4	PE
20MME17	Additive Manufacturing	3	0	0	3	PE
20GET13	Innovation and Business Model Development	3	0	0	3	PE

20AMT12 ADVANCED MATHEMATICS

Programme & Branch	M.E. Mechatronics	Sem.	Category	L	T	P	Credit
Prerequisites	Calculus, Matrices and Laplace Transform	1	FC	3	1	0	4

Preamble	This course will help the students to develop knowledge to identify and formulate problems in mechanical engineering using mathematical tools such as probability, calculus of variations and solve ordinary and partial differential equations by employing transform and numerical techniques.	
Unit - I	**Random Variables and Probability Distributions:**	**9+3**
Random variable – Probability mass function – Probability density function – Moments – Moment generating functions – Discrete distributions – Binomial distribution – Poisson distribution – Geometric distribution – Continuous distributions - Uniform distribution – Exponential distribution – Normal distribution.		
Unit - II	**Calculus Of Variations:**	**9+3**
Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.		
Unit - III	**Transform Methods: Laplace transform methods:**	**9+3**
Solution of one-dimensional wave equation - Solution of one-dimensional heat equation – **Fourier transform methods:** Solution of Diffusion equation – Solution of one-dimensional wave equation – Solution of Laplace equation.		
Unit - IV	**Numerical solution of Ordinary differential equations**:	**9+3**
Runge - Kutta methods for system of IVPs – Numerical stability of Runge - Kutta method – Adams - Bashforth multistep method – Shooting method –Solution of BVP : Finite difference method – Collocation method and orthogonal collocation method.		
Unit - V	**Numerical Solution of Partial Differential Equations:**	**9+3**
Solution of one dimensional wave equation – Solution of diffusion equation – Explicit and implicit methods – Solution of Elliptic equation: Solution of Laplace equation – Solution of Poisson equation.		

Total:45, Tutorial:15, Total: 60

REFERENCES:

1	Richard Johnson, Miller & Freund's, "Probability and Statistics for Engineers", Seventh Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2007.
2	Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3.	Sankara Rao K, "Introduction to Partial Differential Equations", PHI Learning Pvt. Ltd, Third edition, 2011.
4.	Smith, G. D., "Numerical Solutions of Partial Differential Equations: Finite Difference Methods", Clarendon Press, 1985.
5.	Curtis F. Gerald, Patrick O.Wheatley, "Applied Numerical Analysis", Seventh Edition, Pearson Education India, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	handle engineering problems involving discrete and continuous random variables.	Applying (K3)
CO2	solve problems involving functional that occur in various branches of engineering disciplines.	Applying (K3)
CO3	apply Laplace and Fourier transforms solve to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.	Applying (K3)
CO4	solve ordinary differential equations using finite difference and finite element methods.	Applying (K3)

CO5	solve elliptic partial differential equations by using finite difference methods.	Applying (K3)

Mapping of COs with POs and PSOs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	1		
CO2	1		
CO3	3		
CO4	3		
CO5	3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70	-	-	-	100
CAT2	10	20	70	-	-	-	100
CAT3	10	20	70	-	-	-	100
ESE	10	20	70	-	-	-	100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20GET11 INTRODUCTION TO RESEARCH

(Common to Engineering and Technology Branches)

Programme & Branch	M.E. Mechatronics	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	2	1	0	3

Preamble	This course will familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting. Also will disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit - I	**Concept of Research**	**9**
Meaning and Significance of Research: Skills, Habits and Attitudes for Research - Time Management - Status of Research in India. Why, How and What a Research is? - Types and Process of Research - Outcome of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords - Literature Collection – Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit - II	**Research Methods and Journals**	**9**
Interdisciplinary Research - Need for Experimental Investigations - Data Collection Methods - Appropriate Choice of Algorithms / Methodologies / Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations. Journals in Science/Engineering - Indexing and Impact factor of Journals - Citations - h Index - i10 Index - Journal Policies - How to Read a Published Paper - Ethical issues Related to Publishing - Plagiarism and Self-Plagiarism.		
Unit - III	**Paper Writing and Research Tools**	**9**
Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study - When and Where to Publish? - Journal Selection Methods. Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process - Addressing Reviewer Comments. Use of tools / Techniques for Research - Hands on Training related to Reference Management Software - EndNote, Software for Paper Formatting like LaTeX/MS Office. Introduction to Origin, SPSS, ANOVA etc., Software for detection of Plagiarism.		
Unit - IV	**Effective Technical Thesis Writing/Presentation**	**9**
How to Write a Report - Language and Style - Format of Project Report - Use of Quotations - Method of Transcription Special Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc. - Different Reference Formats. Presentation using PPTs.		
Unit - V	**Nature of Intellectual Property**	**9**
Patents - Designs - Trade and Copyright. Process of Patenting and Development: Technological research - innovation - patenting - development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents.		

Total:45

REFERENCES:

1	DePoy, Elizabeth, and Laura N. Gitlin, “Introduction to Research-E-Book: Understanding and Applying Multiple Strategies”, Elsevier Health Sciences, 2015.
2	Walliman, Nicholas, “Research Methods: The basics”, Routledge, 2017.
3.	Bettig Ronald V., “Copyrighting culture: The political economy of intellectual property”, Routledge, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	list the various stages in research and categorize the quality of journals.	Analyzing (K4)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper.	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs and PSOs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	2	1
CO2	3	2	3
CO3	3	3	1
CO4	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy			

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1-50 marks		30	40	30			100
CAT 2-50 marks		30	40	30			100
CAT 3-50 marks			30	40	30		100
ESE -100 marks		30	40	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MMT11 BRIDGE COURSE ELECTRONICS

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	1	0	4

Preamble	This course provides the knowledge on basic working principle and characteristics of electronic devices, electrical drives and special machines.	
Unit - I	**Basic Electronics**	**9**
Intrinsic and Extrinsic Semiconductors – Junction diode Characteristics and its applications – Special purpose diodes: Zener diode – Tunnel diode – Schottky diode – Varactor diode - LED, Photodiode of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulators.		
Unit - II	**Bipolar Junction Transistor**	**9**
CE, CB, CC Configurations and Characteristics –Transistor as an amplifier – JFET – MOSFET – UJT – Need for biasing and biasing methods - Single stage transistor amplifier - Cascading amplifiers – Oscillators.		
Unit - III	**Operational Amplifiers and its Applications**	**9**
Operational amplifier (op-amp) – DC and AC performance Characteristics - Arithmetic operations using op-amp - Applications: Instrumentation amplifier, Sample and Hold circuits, Clippers, Clampers, Peak detectors - Op-amp as comparator - Schmitt trigger - Applications of comparator - Waveform generator: square, sine, triangular waves - Multivibrators - Voltage regulators.		
Unit - IV	**Power Electronics**	**9**
Operating mechanism, characteristics and applications of power diodes, SCR, Diac, Triac, SCS, GTO, LASCR – two transistor model of SCR Controlled Rectifiers: single phase – three phase Rectifying circuits and filters - Regulated power supply – SMPS – UPS.		
Unit - V	**Electrical Drives and Special Machines**	**9**
Basic Elements – Types of Electric Drives – Factors influence the choice of electrical drives – Loading conditions and classes of duty. Constructional details and operation of single phase induction motors – Shaded pole induction motor – Linear reluctance motor – Hysteresis Motor – Servo Motors.		

Lecture:45

REFERENCES:

1	Sedha R.S., “Applied Electronics”, S. Chand & Co., Revised Edition, 2008.
2	Sergio Franco, “Design with operational amplifiers and analog integrated circuits”, 4th Edition, McGraw Higher Ed, 2016.
3	Muhamed H. Rashid, “Power Electronics Circuits, Devices and Applications”, 4th Edition, PHI, 2013.
4	Dubey G.K., “Fundamentals of Electrical Drives”, 2nd Edition, Narosa Publishing House, New Delhi, 2015.
5	Janardanan E.G., “Special Electrical Machines”, PHL Learning Pvt. Ltd., Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basics of semiconductor devices and its relevant characteristics	Analyzing (K4)
CO2	identify the characteristics of BJT and OP-AMPs	Evaluating (K5)
CO3	analyze the performance of OP-AMP and its applications	Creating (K6)
CO4	infer the power electronic devices	Applying (K3)
CO5	explain the basics of electrical drives and special machines	Applying (K3)

Mapping of COs with POs and PSOs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	2	1	2
CO2		1	1
CO3	2	1	2
CO4		1	1
CO5	2	1	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy			

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1-50 marks	20	30	50				100
CAT 2-50 marks	20	20	60				100
CAT 3-50 marks	20	20	60				100
ESE -100 marks	20	20	60				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MMT12 BRIDGE COURSE MECHANICAL

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	1	0	4

Preamble	This course provides the knowledge of basic Mechanical Engineering concepts, mechanisms, design of machine elements and machine tools characteristics.	
Unit - I	**Mechanisms**	**9**
Kinematics – Links, pairs and mechanisms - 4 Bar mechanism – Crank rocker - Slider crank mechanisms – Inversions – Determination of Velocity and acceleration of simple mechanisms.		
Unit - II	**Friction**	**9**
Types of friction – simple contact friction- belt and rope drives - Ratio of tensions- friction in screw and nuts – Bearings- pivot, collar, journal bearings and rolling element - Plate and disc clutches –basics of brakes, Springs – Close coiled and Leaf spring.		
Unit - III	**Operational Amplifiers and its Applications**	**9**
Operational amplifier (op-amp) – DC and AC performance Characteristics - Arithmetic operations using op-amp - Applications: Instrumentation amplifier, Sample and Hold circuits, Clippers, Clampers, Peak detectors - Op-amp as comparator - Schmitt trigger - Applications of comparator - Waveform generator: square, sine, triangular waves - Multivibrators - Voltage regulators.		
Unit - IV	**Power Electronics**	**9**
Operating mechanism, characteristics and applications of power diodes, SCR, Diac, Triac, SCS, GTO, LASCR – two transistor model of SCR Controlled Rectifiers: single phase – three phase Rectifying circuits and filters - Regulated power supply – SMPS – UPS.		
Unit - V	**Electrical Drives and Special Machines**	**9**
Basic Elements – Types of Electric Drives – Factors influence the choice of electrical drives – Loading conditions and classes of duty. Constructional details and operation of single phase induction motors – Shaded pole induction motor – Linear reluctance motor – Hysteresis Motor – Servo Motors.		

Lecture:45,

REFERENCES:

1	Sedha R.S., “Applied Electronics”, S. Chand & Co., Revised Edition, 2008.
2	Sergio Franco, “Design with operational amplifiers and analog integrated circuits”, 4th Edition, McGraw Higher Ed, 2016.
3	Muhamed H. Rashid, “Power Electronics Circuits, Devices and Applications”, 4th Edition, PHI, 2013.
4	Dubey G.K., “Fundamentals of Electrical Drives”, 2nd Edition, Narosa Publishing House, New Delhi, 2015.
5	Janardanan E.G., “Special Electrical Machines”, PHL Learning Pvt. Ltd., Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basics of semiconductor devices and its relevant characteristics	Analyzing (K4)
CO2	identify the characteristics of BJT and OP-AMPs	Evaluating (K5)
CO3	analyze the performance of OP-AMP and its applications	Creating (K6)
CO4	infer the power electronic devices	Applying (K3)
CO5	explain the basics of electrical drives and special machines	Applying (K3)

Mapping of COs with POs and PSOs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	3	1
CO2	3		2
CO3	1	3	3
CO4	1		3
CO5	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy			

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1-50 marks	10	10	50	30			100
CAT 2-50 marks	10	10	50	30			100
CAT 3-50 marks	10	30	60	--			100
ESE -100 marks	10	10	50	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MMT13 CONTROL SYSTEM ENGINEERING

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	1	0	3

Preamble	This course imparts knowledge on the components and their representation of control systems, time response, frequency response, stability of the systems and state variable analysis.	
UNIT – I	**System Modeling:**	**9**
Control System: Terminology and Basic Structure-Feed forward and Feedback control theory– Mathematical modeling: Electrical systems, Mechanical systems, Electro Mechanical systems – Electrical analogous for mechanical systems – Block diagram reduction techniques, Signal flow graph -Mason's gain formula .		
UNIT – II	**Time Response Analysis:**	**9**
Test signals – Time response of I and II order systems – Time domain specifications – Steady state error – Generalized error series – Concepts of stability – Routh Hurwitz criterion – Root locus.		
UNIT – III	**Frequency Response Analysis:**	**9**
Frequency domain specifications – Correlation between time and frequency domain specifications – Bode plot, Polar plot – Nyquist stability criterion.		
UNIT – IV	**Compensators Design:**	**9**
Realization of basic compensators – Cascade compensation in time domain and frequency domain –Design of Lag, Lead and Lag, Lead compensator using root locus - PD, PI,PID control systems		
UNIT – V	**State Space Analysis:**	**9**
Continuous and discrete time state variable theory – State space formulation – State space representation using physical variables, phase variables and canonical variables - Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models – Solution of state equations – Controllability - Observability.		

Lecture:45

REFERENCES:

1	Ogata K., "Modern Control Engineering", 5th Edition, Pearson Education/ PHI, New Delhi, 2015.
2	Nise Norman S., "Control Systems Engineering", 7th Edition, Wiley Publishers, 2018.
3	Nagrath I.J. and Gopal M., "Control Systems Engineering", 6th Edition, New Age International Publishers, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop the mathematical model of an Electrical, Mechanical and Electro mechanical systems	Applying (K3)
CO2	interpret the time response analysis of the system	Applying (K3)
CO3	interpret the frequency response and stability of the system	Applying (K3)
CO4	demonstrate the compensation techniques for stabilizing the system	Applying (K3)
CO5	identify continuous and discrete time state variable theory	Applying (K3)

Mapping of COs with POs and PSOs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy			

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1-50 marks	10	15	75				100
CAT 2-50 marks	10	15	75				100
CAT 3-50 marks	10	15	75				100
ESE -100 marks	10	10	80				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MMT14 SENSORS AND IoT

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	0	0	3

Preamble	This course inculcate the basic knowledge about sensors used to measure various physical quantities like resistance, pressure, flow, level, humidity and understanding the fundamentals of IoT and domain specific deployments.	
UNIT – I	**Introduction to Measurement**	**9**
Units and Standards - Instrument classification - Characteristics of Instruments - Static and dynamic. **Non-electrical Transducers:** Classification of transducers - Temperature Measurement: Filled system thermometer - Bimetallic thermometer - Pressure Transducers: Elastic transducers - Bourdon gauge - Bellows - Diaphragm. Vacuum: McLeod gauge, thermal conductivity gauge - Ionization gauge.		
UNIT – II	**Electrical Transducers**	**9**
Turbine flow meter, Electromagnetic flow meter - Hot wire anemometer - Ultrasonic Meter - Resistive transducers - Potentiometer - RTD - Thermistor - Thermocouple - Radiation Pyrometer.		
UNIT – III	**Force, Displacement, Magnetic and Digital Sensors**	**9**
Strain gauges - Force measurement - Inductive transducer - LVDT - RVDT - Capacitive transducer – Piezo-electric transducer – Magnetic Sensor- Types –Magneto resistive – Hall effect – Current sensor - Digital displacement transducers. Digital transducers: Encoders – Fiber optic sensors – Film sensors - Introduction to MEMS and Nano sensors.		
UNIT – IV	**Internet of Things**	**9**
Introduction- Physical design of IoT – Logical design of IoT- IoT enabling technologies- IoT levels and deployment templates – IoT and M2M – IoT system Management with NETCONF-YANG		
UNIT – V	**IoT Design platform**	**9**
IoT design methodology – steps **–** IoT physical devices- arduino and raspberry pi – interfacing and Programming with sensor applications. **Domain specific IoTs:** Home automation- smart cities –environment – energy – retail – Logistics – agriculture – Industry- health and life style.		

Total:45

REFERENCES:

1	Patranabis D., “Sensor and Actuators”, Second Edition, Prentice Hall of India, 2005.
2	Doebelin E.O., “Measurement Systems - Applications and Design”, 6th Edition, Tata McGraw Hill, New Delhi, 2017.
3	Bahga, A. and Madisetti, V. “Internet of Things: A Hands-On Approach” First edition, Orient Blackswan Private Limited, New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the basic concepts of measurement system and categorize the different type of non-electrical transducers	Understanding (K2)
CO2	correlate the different type of electrical transducers for various applications	Understanding (K2)
CO3	infer the role of sensors in evolving technologies	Understanding (K2)
CO4	demonstrate the basic concepts of Internet of Things and deployment platforms	Understanding (K2)
CO5	develop a sensor based IoT applications and infer the different domain specific IoTs.	Applying (K3)

Mapping of COs with POs and PSOs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	1	2	3
CO2	2	2	3
CO3	2	3	3
CO4	2	2	2
CO5	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy			

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1-50 marks	20	80					100
CAT 2-50 marks	20	80					100
CAT 3-50 marks	10	60	40				100
ESE -100 marks	10	60	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MML11 CONTROL SYSTEM ENGINEERING LABORATORY

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	PC	0	0	2	1
Preamble	This course provides hands-on training on design, develop and analyze the control systems in various forms for real time applications.						

List of Exercises / Experiments:

1.	Study of classification of systems
2.	Transfer function model using block diagram reduction techniques using MATLAB.
3.	Time response analysis of second order system using MATLAB
4.	Development and analysis of mechanical translational system
5.	Development and analysis of mechanical rotational system
6.	Development and analysis of electrical system using op-amp
7.	Development and analysis of electromechanical system using gears
8.	Stability analysis with root locus using MATLAB
9.	Frequency domain analysis with bode plot using MATLAB
10.	Closed loop analysis of PID controller for position control system
11.	Design of compensators for first order system
12.	Design and implementation of simple controller for real time application

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	design, modeling and analysis of systems	Analyzing (K4), Precision (S3)
CO2	analyze the stability of system	Analyzing (K4), Precision (S3)
CO3	design and analyze compensators and controller for various application	Analyzing (K4), Precision (S3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

20MML12 SENSORS AND IoT LABORATORY

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	PC	0	0	2	1
Preamble	This course provides hands-on training on design, develop and analyze the control systems in various forms for real time applications..						

List of Exercises / Experiments:

1.	Measurement of temperature using Thermistor
2.	Measurement of temperature using Thermocouple & RTD.
3.	Measurement of displacement using POT, LVDT & Capacitive transducer.
4.	Measurement of Torque, Strain and Force.
5.	Flow measurement using Orifice meter and Rotameter.
6.	Diaphragm based Pressure measurement.
7.	Capacitive based Level Measurement.
8.	Speed Measurement using Encoder and Optocoupler.
9.	Measurement of magnetic field strength using hall-effect sensor with arduino programming.
10.	Measurement of unknown Resistance using Wheatstone bridge with IoT.
11.	Measurement of unknown Inductance using Maxwell Bridge with IoT.
12.	Measurement of unknown Capacitance using Schering Bridge with IoT.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the characteristics of temperature , displacement , capacitive and strain gauge sensor and transducers	Understanding (K2), Imitation (S1)
CO2	demonstrate the characteristics of non-electrical and electrical sensors and transducers	Understanding (K2), Imitation (S1)
CO3	experiment with different sensor applications with IoT deployment	Applying (K3), Manipulation (S2)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	2	2	2
CO2	2	2	2
CO3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

20MMC21 FLUID POWER SYSTEM

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	PC	3	0	2	4

Preamble	This course deals with the design of a system which generate, control and transmission of power using pressurized fluids.	
Unit - I	**Fundamentals and Power Source of Hydraulic System:**	**9**
Basics, Types and structure of fluid power systems – Pascal's Law and its application –Fluid properties – Losses in pipes, valves and fittings – Advantages and applications of Fluid power systems. Fluid power symbols – Hydraulic pumps: Gear, Vane and Piston pumps, Pump Performance, Characteristics and Selection - Sizing of hydraulic pumps.		
Unit - II	**Control Components of Hydraulic System:**	**9**
Direction control valves: Three-way valve, Four way valve, Check valve and shuttle valve – Actuation mechanism of DCV – Pressure control valves: Pressure relief, Pressure Reducing, Counter balance, Sequencing and Unloading Valves – Flow control valves and its types – Proportional Valves – Servo valves and its types.		
Unit - III	**Fundamentals of Pneumatic System:**	**9**
Perfect Gas laws – Compressors: piston, screw and vane compressor – Fluid conditioning Elements: Filter, Regulator and Lubricator unit, Pneumatic silencers, After coolers, Air dryers – Air control valves – Fluid power actuators: Linear and Rotary actuators – types – Cushioning mechanism in cylinders – Sizing of Actuators.		
Unit - IV	**Fluid Power Circuit Design:**	**9**
Circuit design methods: Cascade method, Step counter method and KV Map method (two / three-cylinder circuits) – Basic pneumatic circuits – Electrical components and electrical controls for Fluid power circuits – Introduction to Fluid logic devices and applications – Accumulator: Types and application circuits – Pressure intensifier circuits – PLC applications in Fluid power circuit.		
Unit - V	**Industrial Circuits and Maintenance:**	**9**
Industrial circuits: Speed control circuits – Regenerative cylinder circuits – Pump unloading circuit – Double pump circuit – Counter balance valve circuit – Hydraulic cylinder sequencing circuit – Automatic cylinder reciprocating circuit – Cylinder synchronizing circuits – Fail safe circuits - Sealing devices: Types and materials – Installation, Maintenance and trouble shooting of Fluid Power systems.		

List of Exercises / Experiments:

1.	Design and testing of speed control circuits (Meter in, Meter out and Bleed off circuits)
2.	Design and testing of Electro-hydraulic circuit with pressure sequence valve
3.	Design and testing of Sequential circuit with pneumatic control (with and without time delay)
4.	Design and testing of Electro Pneumatic sequential circuit with limit switches
5.	Design and testing of Pneumatic circuits with logic controls – AND valve and OR valve
6.	Design and simulation of Sequential fluid power circuits using cascade method
7.	Design and testing of Pneumatic circuit with vacuum cup and rod less cylinder
8.	Design and testing of Hydraulic circuit with Proportional control of Pressure and Flow
9.	Design and testing of sequential circuits using cascade method
10.	Design, testing and simulation of electro pneumatic circuit with timers and counters

Lecture:45, Practical:30, Total:75

REFERENCES:

1.	Esposito Anthony, "Fluid Power with Applications", 7th Edition, Pearson Higher Education, New York, 2015.

2.	Jegadeesa T., "Hydraulics and Pneumatics", I.K International Publishing House Pvt. Ltd., New Delhi, 2015.
3.	Majumdar S.R., "Oil Hydraulic Systems – Principles and Maintenance", 2nd Edition, Tata McGraw-Hill, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify fluid power components and their symbols as used in industry and also select suitable pump for hydraulic power pack	Understanding (K2) Imitation (S1)
CO2	choose appropriate control valves for fluid power applications	Applying (K3) Manipulation (S2)
CO3	select pneumatic components and fluid power actuators for low cost automation	Analysing (K4) Precision (S3)
CO4	design and construct a fluid power circuits real time applications	Applying (K3) Manipulation (S2)
CO5	design, construct, test, install, maintain and trouble shoot fluid power circuits for engineering applications	Analysing (K4) Precision (S3)
CO6	Select the appropriate fluid power components and their symbols to design and simulate the industrial circuits	Applying (K3), Precision (S3)
CO7	design, construct and test fluid power circuits with Manual, Mechanical, hydraulic, pneumatic and electrical actuation methods for low cost automation	Applying (K3), Precision (S3)
CO8	develop and simulate fluid power circuits using simulation software for industrial applications	Applying (K3), Precision (S3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1		2	
CO2	2		1
CO3	2		1
CO4		1	3
CO5	2	2	3
CO6	2	2	3
CO7	2	2	3
CO8	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	60	30	-	-	-	100
CAT2	10	55	35	-	-	-	100
CAT3	10	40	50	-	-	-	100
ESE	15	50	35	-	-	-	100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MMC22 ROBOT KINEMATICS AND DYNAMICS

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Bridge Course Mechanical and Advanced Mechatronics	2	PC	3	0	2	4

Preamble	The course on Robotics Engineering is intended to provide a reasonable understanding of robotics and robot anatomy, the mathematics behind kinematics and dynamics of robot. It also involves controlling the robot motion using different control strategies.	
Unit - I	**Introduction**	**9**
History of robotics – Robot Anatomy – Robot specifications - Work space – Degree of freedom - Joint types - Types of robots – Precision of movements - End effectors – Dexterity - Robot applications.		
Unit - II	**Robot Kinematics**	**9**
Descriptions: Position, Orientations and translation – Mapping: Changing from frame to frame – Operators: Translations, Rotation and Transformation - Homogeneous Transformation matrices - Forward and Inverse kinematics - Representation of links using Denavit - Hartenberg parameters		
Unit - III	**Velocity and Static Force**	**9**
Introduction - Linear and angular velocities of a rigid body - Velocity propagation – Derivation of Jacobian matrix for Serial manipulator – Singularities - Static force of serial manipulator.		
Unit - IV	**Robot Dynamics**	**9**
Acceleration of a rigid body - Inertia of a link - Equations of motion for serial manipulators: Euler Lagrange formulation, Newton Euler formulation –– Inverse dynamics of serial manipulator.		
Unit - V	**Robot Control**	**9**
Point to point and Continuous path motions – Joint trajectory Vs Cartesian trajectory – Trajectory planning – Trajectory following - Disturbance rejection – PD and PID control – Computer torque control - Adaptive control – Feedback linearization control.		

List of Exercises / Experiments:

1.	Study the functions of ABB IRB 1410 industrial robot- components, drive system and end effectors.
2.	Virtual reality robot programming for different tasks- Painting, Pick and place and switch off intruder alarm.
3.	Virtual reality robot programming for different tasks- Stacking of blocks and Machining of billets.
4.	Creation of Tool Centre Point (TCP) and Work Object using ABB IRB 1410 industrial robot.
5.	Pick and place operation in teach mode using ABB IRB 1410 industrial robot.
6.	Machine tending operation in teach mode using ABB IRB 1410 industrial robot.
7.	Robot programming exercises - Point-to-point programming.
8.	Robot programming exercises - Continuous path programming.
9.	Robot programming exercises – Path planning in offline mode.
10.	Vision based On-line Inspection and sorting of components using ABB IRB 1410 industrial robot.

Lecture:45, Practical:30, Total:75

REFERENCES:

1.	Groover M.P., Weiss M., Magel R.N., Odrey N.G. and Dulta A., "Industrial Robotics, Technology, Programming and Applications", 2nd Edition, McGraw-Hill Companies, 2012.
2.	Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd Edition, Wiley India Pvt. Ltd., 2012.
3.	Craig John J., "Introduction to Robotics: Mechanics and Control", 4th Edition, Pearson/Prentice Hall Publication, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the industrial manipulator anatomy and estimate the gripping force of robot end effector	Applying (K3)
CO2	develop the forward and inverse kinematics for serial manipulators	Applying (K3)
CO3	formulate Jacobian matrix for velocity and static force analysis of serial manipulators	Applying (K3)
CO4	formulate dynamic equations for serial manipulators	Applying (K3)
CO5	apply the scheme of trajectory planning and control for manipulator motion control	Applying (K3)
CO6	analyze the industrial robot work cell problems	Analyzing (K4), Manipulation (S2)
CO7	develop robot programming through online /offline mode	Creating (K6), Precision (S3)
CO8	develop an online inspection system using machine vision	Creating (K6), Precision (S3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	2	-	3
CO2	2	-	3
CO3	2	-	3
CO4	2	-	3
CO5	2	-	3
CO6	2	3	3
CO7	3	3	3
CO8	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MMT21 EMBEDDED SYSTEM AND CONTROL

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Bridge Course Mechanical and Advanced Mechatronics	2	PC	3	0	0	3

Preamble	Microcontroller has become important building block in digital electronics design. 8051/PIC microcontroller architecture, programming, and interfacing is dealt in detail in this course. Interfacing, assembly language programming and interfacing of 8051/PIC microcontroller and its application in industry are also covered in this course.	
Unit - I	**8051 Microcontroller**	**9**
Microcontroller and embedded processors - Overview of the 8051 family - 8051 microcontroller architecture - Memory organization of 8051 - PSW register - Register banks and stack, Input/ Output ports, pins.		
Unit - II	**8051 Embedded C Programming**	**9**
Introduction to Embedded C Programming - Timer/Counter - Serial Communications Interrupts - Instruction set - Addressing modes - I/O port Programming - Timer / counter programming - Serial communications Programming - Interrupt Programming.		
Unit - III	**PIC Microcontrollers Architecture**	**9**
PIC microcontroller overview and features - Harvard architecture - Pipelining – Architecture of PIC18-PinDescription-Memory organization: Program memory-Data Memory -Register Organization.		
Unit - IV	**PIC 18 Features**	**9**
I/O Ports Timers Counters-Capture/ Compare - PWM- External Hardware Interrupts- USART-ADC-Interfacing to External memory.		
Unit - V	**PIC 18 Embedded C Programming**	**9**
Addressing Modes - Instruction set-Simple Programs. I/O port programming - Timer/Counter programming - Serial communications Programming - ADC Programming - Application case studies.		

Total:45

REFERENCES:

1. Mazidi Muhammad Ali and Mazidi Janice Gillispie, “The 8051 Microcontroller and Embedded Systems”, 2nd Edition, Pearson Education, 2013.
2. Mazidi Muhammad Ali, Mckinlay Rolin .D., and Causey Danny,“PIC Microcontroller and Embedded Systems using Assembly and C for PIC18”, Pearson Education Asia, 2008.
3. David Den Haring, Kai Qian, and Li Cao., “Embedded Software Development With C”, Springer, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the organization of 8051 microcontroller and its programming concepts	Understanding (K2)
CO2	interpret the basic architecture and features of PIC18 microcontroller	Understanding (K2)
CO3	develop Embedded C programming for 89c51 and PIC microcontroller	Applying (K3)
CO4	experiment with microcontroller hardware for a given industrial application	Applying (K3)
CO5	develop microcontroller hardware for industrial applications	Creating (K6)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	1	1	2
CO2	1	1	2
CO3	3	2	2
CO4	3	2	3
CO5	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	50				100
CAT2	20	20	60				100
CAT3	10	20	70				100
ESE	10	30	70				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MMT22 INTEGRATED AUTOMATION CONTROLLERS

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Sensors and IOT	2	PC	3	0	0	3

Preamble	This course is intended for learning the device layer components and Architecture and Operations of programmable logic controller, Fundamentals of Programming and problem solving using logic ladder diagrams. This course is also giving the ideas of Fundamentals Networking of PLC, SCADA architecture and Distributed control system and its case studies.	
Unit - I	**Device Layer Components:**	**9**
Input Devices- Pushbuttons – Proximity Sensors- Read switch –float switch-pressure switch-temperature switch-limit switch-Encoders – MCB - Output Devices – Relays – Contactors – OLR – DOL Starter - Solenoid valves- relay logic program for simple industrial case studies.		
Unit - II	**Programmable Logic Controller:**	**9**
Parts of PLC – Principles of operation – PLC sizes – PLC hardware components – I/O modules – Programming devices- different modes of PLC operation-maintenance and troubleshooting procedure.		
Unit - III	**PLC Programming:**	**9**
Types of PLC programming – Simple instructions – Latching relays - Converting simple relay ladder diagram into PLC ladder diagram-Timer instructions – On Delay, Off Delay and Retentive Timers – Counter instructions – Up Counter, Down Counter and Up Down Counters- Program control instructions – Data manipulating instructions, math instruction – Closed loop control.		
Unit - IV	**Networking of PLC and SCADA:**	**9**
Networking of PLCs – Data communication –– data highway- serial communication- device net –control net – Ethernet IP –Modbus- field bus – Profibus DP - OPC function. Supervisory Control and Data Acquisition – Architecture – Remote terminal units – Master Terminal units – Operator interface – security considerations – alarming- control change screen- status screen-graphics and trending – reports.		
Unit - V	**Distributed Control System and Case Studies:**	**9**
Evolution – Architectures – Comparison – Local control unit – Process interfacing issues – Communication facilities. Operator interfaces – Low level and high-level operator interfaces – Operator displays – Engineering interfaces – Low level and high-level engineering interfaces – Applications of DCS in – Pulp and paper environment – Petroleum – Refining environment.		

Total: 45

REFERENCES:

1. Petruzella Frank D., "Programmable Logic Controllers", 4th Edition, McGraw-Hill, New York, 2016.
2. Webb John, W and Reis Ronald A., "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall of India, New Delhi, 2011.
3. Stuart Boyer A., "SCADA Supervisory Control and Data Acquisition", 4th Edition ISA, USA, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	infer the device layer components functions and its role in industrial automation system	Understanding (K2)
CO2	explain the PLC architecture, Programming device, installation procedures and trouble shooting	Applying (K3)
CO3	develop PLC program using diverse functions of PLCs for a given application	Applying (K3)
CO4	explain the basic networking protocols for PLC, application development procedures in SCADA and manage data, alarm and storage	Understanding (K2)
CO5	illustrate the architecture of DCS, interfaces and its applications	Understanding (K2)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	2	2	3
CO2	2	2	3
CO3	3	2	3
CO4	3	2	3
CO5	2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	60	30				100
CAT2	10	50	50				100
CAT3	20	80					100
ESE	10	60	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MML21 EMBEDDED SYSTEM AND PLC LABORATORY

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	PC	0	0	2	1
Preamble	This course provides hands on training on concepts of Embedded programming and PLC programming in real time applications.						

List of Exercises / Experiments:

1.	Introduction to Embedded C programming and simulation software
2.	Interfacing of switch, LED and seven segment LED
3.	Interfacing of LCD
4.	Interfacing of high power devices for the given case study
5.	Study on Interfacing sensors, microcontroller with IoT module
6.	Introduction to programming /simulation/communication software for PLC programming
7.	logical testing of I/Os and its interfacing with PLC
8.	Level control using PLC
9.	Linear and sequential actuation of Pneumatic cylinder with Timer and counter functions
10.	Development of HMI for real time parameter monitoring and control

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	build and simulate Embedded C programming for 89C51 microcontroller	Analyzing (K4), Precision (S3)
CO2	build and simulate PLC programming for discrete and analog I/Os	Analyzing (K4), Precision (S3)
CO3	develop plant level automation for real process plant control using Microcontroller, PLC and SCADA	Analyzing (K4), Precision (S3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

20MME01 COMPUTER NUMERICALLY CONTROLLED MACHINES

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	I	PC	3	0	0	3

Preamble	This course provides the fundamental knowledge and programming concepts of CNC machines.	
UNIT – I	**Construction Features of CNC Machines**	**9**
Introduction - CNC Machine Building, Drives and Controls: Drive Mechanism, Spindle Drives, Axes drives, Feed drives, Linear Motors and Actuators, Magnetic Levitation. Power transmission elements - Spindle bearing – Arrangement and installation - Guide ways – Configuration and design, friction and anti-friction LM guide ways, Retrofitting.		
UNIT – II	**Control Systems for CNC Machines and CAD/CAM Integration:**	**9**
Interfacing – Monitoring – Diagnostics – Machine data – Sources of errors - Compensations for Machine accuracy – DNC – Adaptive control CNC systems. Concepts of High speed Machining and micro machining. Networking - networking techniques, LAN, components - Graphics standards – Data exchange format, evolution - features of various interfaces GKS, IGES, DXF, PDES, STEP etc., Process planning, Computer Aided process planning (CAPP) - Variant, generative Approaches.		
UNIT – III	**CNC Programming:**	**9**
Structure of CNC program, Part Program Terminology Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, sub routines, mirroring features, Manual part programming for CNC turning and machining centre – APT programming for various machines in FANUC - Computer aided part programming - Post processing.		
UNIT – IV	**Tooling System and Management:**	**9**
Tooling system - Interchangeable tooling system – Preset, Qualified and semi-qualified tools – Coolant fed tooling system – Modular fixturing – Quick change tooling system – Automatic head changers – Tooling requirements for Turning and Machining centers – Tool holders – Tool assemblies – Tool Magazines – ATC Mechanisms – Tool management.		
UNIT – V	**Economics of CNC Operations**	**9**
Factors influencing selection of CNC machines - Cost of operation of CNC machines - Practical aspects of introducing CNC machines - Maintenance features of CNC machines - Preventive and other maintenance requirements.		

Total: 45

REFERENCES:

1. Michael Fitzpatrick N.E., and Arlington W.A., "Machining and CNC Technology", 3rd Edition, Mc Graw Hill Education, 2014.
2. Alan Overby, "CNC Machining Handbook: Building, Programming and Implementation", The McGraw-Hill Companies Inc., 2011.
3. Peter smid, "CNC Programming Handbook", 3rd Edition,. Industrial Press Inc., 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Explain the basic components and mechanisms of CNC system	Understanding (K2)
CO2	Interpret the control system concepts used in CNC machine	Understanding (K2)
CO3	Formulate part programming for turning and milling Process	Applying (K3)
CO4	select proper tooling systems and fixtures for holding the work piece	Understanding (K2)
CO5	Infer the economic concepts of CNC machines	Understanding (K2)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	2	1	1
CO2	3	3	1
CO3	3	2	2
CO4	3	1	1
CO5	2	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	80					100
CAT2	20	65	15				100
CAT3	20	80					100
ESE	20	70	10				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME02 INDUSTRIAL DRIVES

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	I	PC	3	0	0	3

Preamble	This course depicts the working principles of power electronic devices, converters, drives and their applications.	
UNIT – I	**Power Electronics Devices:**	**9**
Concept of Power Electronics – Power Semiconductor Devices - Principle of operation – Steady state and switching characteristics of power diodes, power BJT, power MOSFET, IGBT – Firing circuit for thyristor- Steady state and switching characteristics of SCR –Two transistor model of SCR – DIAC – TRIAC – GTO.		
UNIT – II	**AC-DC and DC-AC Converters:**	**9**
Principle of phase controlled converter with R and RL load - freewheeling Diode- single phase full wave converter – single phase semi converter – three phase semi converter – three phase fully controlled converter – Introduction to inverter –1ϕ and 3ϕ Voltage source inverters –PWM inverters.		
UNIT – III	**DC - DC and AC - AC Converter:**	**9**
DC Chopper – Control strategies – Principle of operation – Step up and step down chopper – Single phase AC voltage controller – On - off control and phase control – Sequence control of AC voltage controller – 1ϕ Step up and step down cycloconverters .		
UNIT – IV	**Electric Drives:**	**9**
DC Drives **-** Introduction to DC drives – Basic performance equations of DC motor – single phase DC drives – three phase DC drives – Chopper Drives – two quadrant chopper drive – four quadrant chopper drive.		
UNIT – V	**AC Drives**	**9**
Introduction – Induction motor drives – speed control of 3-phase induction motor – stator voltage control – stator frequency control – stator voltage and frequency control – stator current control – static rotor resistance control – slip power recovery control.		

Total: 45

REFERENCES:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Singh M.D. and Kanchandhani K.B.,"Power Electronics" Tata McGraw – Hill Publishing Company, 2007.
3. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the operation and switching characteristics of power solid state devices	Understanding (K2)
CO2	describe the working principle of AC – DC and DC – AC converters	Understanding (K2)
CO3	express the construction and working of DC – DC and AC–AC converters	Applying (K3)
CO4	select a suitable power converter for a given DC drive	Understanding (K2)
CO5	choose an appropriate power converter for a given AC drive	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	1	2
CO2	3	1	2
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30				100
CAT2	25	40	20	15			100
CAT3	30	30	20	20			100
ESE	25	35	20	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME03 METROLOGY AND COMPUTER AIDED INSPECTION

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Sensors and IOT	I	PC	3	0	0	3

Preamble	This course make the learner to design and fabricate inspection methods and systems incorporating electronic systems for inspection and quality control in engineering.	
UNIT – I	**Linear and Angular Measurements:**	**9**
Basic concept – Legal metrology- Precision- Accuracy- Types of errors – Standards of measurement- traceability – Interchange ability and selective assembly, gauge blocks, limit gauges - Gauge design. Comparators: mechanical, electronic, optical and pneumatic - Angular measurement: bevel protractor - Angle gauges - Sine bar – Autocollimator - Profile projectors.		
UNIT – II	**Surface Finish and Form Measurement:**	**9**
Measurement of surface finish: terminology – Roughness – Waviness – Evaluation of surface finish - Stylus probe instrument – Talysurf – Screw thread metrology: errors in thread – Pitch error – Measurement of various elements - Two and three wire method - Best wire size - Thread gauges - Floating carriage micrometer. Measurement of gears - Terminology- Measurement of various elements of gear - Tooth thickness - Constant chord and base tangent method - Parkinson Gear Tester.		
UNIT – III	**Laser Metrology:**	**9**
Characteristics of LASER sources, LASER micrometer, LASER interferometer – Constructional features - Sources of errors – Measurement of position error, straightness and angle of machine tools, LASER alignment telescope, LASER triangulation techniques. In-process and post process gauging, Automatic gauging, Tool wear measurement, Roundness measurement using LASER, Flexible inspection systems.		
UNIT – IV	**Co-Ordinate Measuring Machines:**	**9**
Coordinate Metrology, types of CMM, constructional features - Structural elements - Drive systems -Support systems - Displacement transducers - Probing system – Software - Control system, temperature fundamentals and accuracy enhancement		
UNIT – V	**Image Processing and Machine Vision System:**	**9**
Image processing: Image acquisition and digitization – Windowing – Segmentation - Thresholding - Edge detection techniques, interpretation - Grey scale correlation – Template matching, applications in Inspection, interfacing machine vision and robot, Reverse engineering Applications.		

Total: 45

REFERENCES:

1. Connie Dotson, Roger Harlow and Richard Thompson, “Fundamentals of Dimensional Metrology”, 4th Edition, Thompson Asia, Singapore, 2003.
2. Jain R.K., “Engineering Metrology”, 21st Edition, Khanna Publishers, New Delhi, 2018.
3. Gupta I.C., “A Text Book of Engineering Metrology”, 7th Edition, Dhanpat Rai Publications, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer linear and angular measurements using various instruments	Understanding (K2)
CO2	determine the surface roughness and form features measurements	Applying (K3)
CO3	appraise laser Interferometry and recent advancements in metrology	Applying (K3)
CO4	make profile measurements using Coordinate Measuring Machine (CMM)	Applying (K3)
CO5	apply the principle of image processing and machine vision system techniques	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	2	2
CO2	3	2	2
CO3	3	2	2
CO4	3	2	2
CO5	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	50	30				100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME04 MEMS DESIGN

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Sensors and IOT and Bridge course mechanical	II	PC	3	0	0	3

Preamble	This course equips the students to understand the concepts of Micro mechatronics and apply the knowledge of micro fabrication techniques for various applications.	
UNIT – I	**Materials for MEMS and Scaling Laws**	**9**
: Overview - Microsystems and microelectronics - Working principle of Microsystems - Si as a substrate material - Mechanical properties - Silicon compounds - Silicon piezo resistors - Gallium arsenide - Quartz-piezoelectric crystals - Polymer - Scaling laws in Miniaturization.		
UNIT – II	**Micro Sensors, Micro Actuators:**	**9**
Micro sensors - Micro actuation techniques - Micro actuators – Micromotors – Microvalves – Micro grippers – Micro accelerometer: introduction, types, actuating principles, design rules, modeling and simulation, verification and testing, applications.		
UNIT – III	**Mechanics for Microsystem Design:**	**9**
Static bending of thin plates - Mechanical vibration - Thermo mechanics - Thermal stresses - Fracture mechanics - Stress intensity factors, fracture toughness and interfacial fracture mechanics-Thin film Mechanics-Overview of Finite Element Stress Analysis.		
UNIT – IV	**Fabrication Process and Micromachining:**	**9**
Photolithography - Ion implantation - Diffusion – Oxidation – CVD - Physical vapor deposition - Deposition by epitaxy - Etching process- Bulk Micro manufacturing - Surface micro machining – LIGA –SLIGA.		
UNIT – V	**Micro System Design, Packaging and Applications:**	**9**
Design considerations - Process design - Mechanical design – Mechanical Design using Finite Element Method-Micro system packaging – Die level - Device level - System level – Packaging techniques - Die preparation - Surface bonding - Wire bonding – Sealing - Applications of micro system in Automotive industry: Bio medical, Aerospace and Telecommunications – CAD tools to design a MEMS device.		

Total: 45

REFERENCES:

1. Tai-Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata McGraw-Hill, New Delhi, 2008.
2. Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC Press, 2009.
3. Bao M.H., “Micromechanical Transducers: Pressure sensors, accelrometers, and gyroscopes”, Elsevier, New York, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the concepts of MEMS materials and scaling laws	Remembering (K1)
CO2	explain the principles of micro sensors and actuators	Understanding (K2)
CO3	apply the mechanics for micro system design	Applying (K3)
CO4	design and fabrication of microsystem	Applying (K3)
CO5	design of microsystem packaging and application	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	2	2	2
CO2	2	2	3
CO3	2	2	3
CO4	3	2	3
CO5	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	30	10			100
CAT2	20	40	30	10			100
CAT3	10	40	30	20			100
ESE	20	30	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME05 VIRTUAL INSTRUMENTATION

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	II	PC	3	0	2	4

Preamble	This course is designed to impart the principles in programming technique with different instrument interfaces and the basics of data acquisition system introduced in real time.	
UNIT – I	**Virtual Instrumentation**	**9**
Historical perspectives, advantages, block diagram and architecture of a virtual instrument, data -flow techniques, graphical programming in data flow, comparison with conventional programming– Graphical user interfaces – Controls and Indicators – 'G' programming/ modular programming .		
UNIT – II	**VI Software Tools:**	**9**
Data types – Data flow programming – Editing, Debugging and Running a Virtual Instrument – Graphical programming palettes and tools – Function and Libraries – Structures: FOR Loops, WHILE loops, Shift Registers, CASE structure, Formula nodes, Sequence structures, Timed looped structures.		
UNIT – III	**VI Programming Techniques:**	**9**
Arrays and Clusters – Bundle/Unbundle and Bundle/Unbundle by name – Plotting data: graphs and charts – String and File I/O: High level and Low level file I/O's – Attribute nodes – Local and global variables - Sub-VI.		
UNIT – IV		**9**
Data Acquisition Hardware: Basics of DAQ Hardware and Software – Concepts of Data Acquisition and terminology – Installing Hardware and drivers – Configuring and addressing the hardware – Digital and Analog I/O function – Real time Data Acquisition – USB based DAQ.		
UNIT – V		**9**
VI applications: Advantages and Applications: TCP/IP VI's – PXI – Instrument Control – Image acquisition – Motion Control – Signal processing/ analysis – Control design and simulation.		

List of Exercises / Experiments :	
1.	GSD using For loops, while loops with shift registers / feedback nodes
2.	GSD using Local variables, Global variables, Case structures and Sequence structures
3.	GSD using Timed structures, Formula nodes and Event structures
4.	GSD using Waveform graph, Waveform chart, XY graph
5.	GSD using String functions, editing, formatting and parsing string
6.	GSD using Arrays functions and multi-dimensional arrays
7.	GSD using Clusters operations: assembling clusters and disassembling clusters
8.	GSD real time measurement using Thermistor / Piezo-electric sensor

Lecture:45, Practical:30, Total: 75

REFERENCES:

1.	Jeffery Travis and Jim Kring, "LabVIEW for Everyone: Graphical programming made easy and Fun", 3rd Edition, Pearson Education, India, 2009.
2.	Gupta, Joseph and John, "Virtual Instrumentation using LabVIEW", 2nd Edition, Tata McGraw Hill, 2010.
3.	Rick Bitter, "LabVIEW Advanced Programming Techniques", 2nd Edition, Taylor & Francis Group, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the basic concepts about virtual instrumentation	Applying (K3)
CO2	interpret the software tools in virtual instrumentation	Applying (K3)
CO3	develop programming through LabVIEW graphical programming environment	Applying (K3)

CO4	experiment with data acquisition hardware and LabVIEW software	Applying (K3)
CO5	select the hardware and software concept of data acquisition system for advanced applications	Applying (K3)
CO6	interpret the software tools in virtual instrumentation	Applying (K3), Manipulation (S2)
CO7	develop programming through LabVIEW graphical programming environment	Applying (K3), Manipulation (S2)
CO8	perform interface of data acquisition hardware with LabVIEW software	Applying (K3), Manipulation (S2)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	**2**	1	2
CO2	3	1	3
CO3	3	1	3
CO4	3	1	3
CO5	3	1	3
CO6	3	1	3
CO7	3	1	3
CO8	3	1	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	10	30	30	30			100
CAT3	10	30	30	30			100
ESE	15	25	40	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME06 FACTORY AUTOMATION AND CIM

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	II	PC	3	0	0	3

Preamble	This course impart fundamental knowledge about automation in the field of production and assembly lines.	
UNIT – I	**Introduction to Automation:**	**9**
Principles and strategies - Elements of an automated system –Levels of automation – Automation in production systems – Automated manufacturing systems – Types – Reasons for automation. Material handling systems – Types – Design considerations – AGVs – Types and applications – Vehicle guidance technology - Storage systems – Performance – Methods – Automated storage systems.		
UNIT – II	**Transfer Machines:**	**9**
Types, transfer machines for housing type parts, transfer systems, turning devices, pallets, mechanisms for locating and clamping housing type parts. Transfer machines for shaft production and gear production. Continuous rotary transfer lines - Layout and output. Transfer lines, Automatic Pallet Changer, Modular Fixtures.		
UNIT – III	**Production Planning & Control and Computerised Process Planning**:	**9**
Process Planning –Computer Aided Process Planning (CAPP) –Logical steps in Computer Aided Process Planning – Aggregate Production Planning and Master Production Schedule –Material Requirement Planning –Capacity Planning -Control Systems -Shop Floor Control -Inventory Control. Brief on Manufacturing Resource Planning (MRP-II) and Enterprise Resource Planning (ERP) –Supply Chain Management (SCM) –Simple Problems		
UNIT – IV	**Cellular Manufacturing:**	**9**
Group Technology(GT), Part Families –Parts Classification and Coding –Simple Problems in Opitz Coding system – Production Flow Analysis –Cellular Manufacturing –Composite part concept –Machine cell design and layout – Quantitative analysis in Cellular Manufacturing –Rank Order Clustering Method –Arranging Machines in a GT cell – Hollier Method –Simple Problems..		
UNIT – V	**CAQC and Production Planning:**	**9**
Benefits of CAQC - Computer Aided Inspection - Contact and Non-contact Inspection Methods - Optical and Non-optical types - Computer Aided Testing - Co-ordinate Measuring Machines (CMM).		

Total: 45

REFERENCES:

1. Groover M.P., "Automation, Production Systems, and Computer-integrated Manufacturing", 4th Edition, Pearson Education, 2016.
2. Groover M.P. and Zimmers E.W., "Computer Aided Design and Manufacturing", Pearson Education, 2011.
3. Nand K. Jha, "Handbook of Flexible Manufacturing Systems", Academic Press, Orlando, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the automation principles, automated manufacturing systems and material handling systems	Understanding (K2)
CO2	demonstrate about the transfer machines for production process	Applying (K3)
CO3	prepare the process plan and classify the parts using different coding methods	Understanding (K2)
CO4	identify the coding systems for different manufacturing parts in a manufacturing industry	Applying (K3)
CO5	Illustrate computer aided quality control techniques and production planning methods in a manufacturing environment	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	2	1	2
CO2	3	2	3
CO3	3	1	2
CO4	2	2	2
CO5	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**30**	**60**	**10**				
CAT2	**20**	**60**	**20**				
CAT3	**15**	**65**	**20**				
ESE	**15**	**65**	**20**				

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME07 PROCESS CONTROL ENGINEERING

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	II	PE	3	0	0	3

Preamble :	This course imparts knowledge on process dynamics and process characteristics. It emphasizes on types of control, tuning of controllers and advanced control systems. This course also includes instrumentation needed for process control and applications of various process control systems.	
UNIT – I	**Introduction to Process Dynamics**	**9**
Process Control - Automatic Process Control - Need for Automatic Process Control in Industry - Mathematical Modeling of Processes – First Order Process Systems - level, temperature and pressure - Second Order Process Systems - Interacting and Non-Interacting Systems - Batch and Continuous Process - Self Regulation - Servo and Regulator Operation.		
UNIT – II	**Control Characteristics and Tuning:**	**9**
Automatic Controller - Process Characteristics - Control System Parameters - Discontinuous Controller Modes - Continuous Controller Modes - Composite Control Modes. Evaluation Criteria: Performance Criteria - Controller Tuning: Process Reaction Curve Method - Ziegler-Nichols Method.		
UNIT – III	**Control Systems with Multiple Loops:**	**9**
Advanced Control Systems - Feed Forward Control - Cascade Control - Ratio Control - Selective Control Systems - Split-Range Control - Adaptive Control - Inferential Control – Multi Variable Control.		
UNIT – IV	**Process Instrumentation:**	**9**
Signal converters: I/P and P/I converters **–** Control valves: characteristics, valve positioner, selection of control valves - Introduction to transmitters, two wire and four wire transmitters, Smart and Intelligent Transmitters.		
UNIT – V	**Process Control Systems:**	**9**
Boiler, Reactor, Mixing Controls, Evaporation, Dryer, Heat Exchanger, Distillation Process.		

Total: 45

REFERENCES:

1.	Krishnaswamy K., "Process Control", 2nd Edition, New Age International Pvt. Ltd. Publishers, New Delhi, 2013.
2.	George Stephanopoulos, "Chemical Process Control-An Introduction to Theory and Practice", 1st Edition, PHI Learning Pvt. Ltd., New Delhi, 2012.
3.	Johnson C.D.,"Process Control Instrumentation Technology", 8th Edition, Prentice-Hall, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop the dynamics of processes using mathematical approach and interpret the characteristics of processes	Applying (K3)
CO2	propose the suitable control modes and examine the tuning of controllers	Analyzing (K4)
CO3	recommend the advanced control system for various process	Applying (K3)
CO4	choose the instrumentation to control the process	Understanding (K2)
CO5	apply suitable control for process control systems	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME08 APPLIED FINITE ELEMENT METHOD

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Strength of Materials	II	PE	3	0	0	3

Preamble:	This course gives an introduction to the finite element method which uses different numerical methods for solving a system of governing equations over the domain of a continuous physical system, which is discretized into simple geometric shapes called finite element.	
UNIT – I	**Introduction to FEA:**	**9**
Introduction to finite element analysis – Discretization – Matrix algebra – Gauss elimination method – Governing equations for continuum – Classical Techniques in FEM. Weighted residual method – Ritz method. Potential energy approach – Galerkin approach for one and two dimensions		
UNIT – II	**One Dimensional Elasticity Problems:**	**9**
Introduction to 2-D Finite element modeling – Plane stress – Plane Strain – Displacement Equations – Element Matrices – Element Equations – Formulation using Natural Coordinates.		
UNIT – III	**Two Dimensional Elasticity Problems:**	**9**
Introduction to 2-D Finite element modeling – Plane stress – Plane Strain – Displacement Equations – Element Matrices – Element Equations – Formulation using Natural Coordinates.		
UNIT – IV	**Axisymmetric Elements:**	**9**
Axisymmetric formulation – Element stiffness matrix and force vector – Galerkin approach – Body forces and temperature effects – Stress calculations – Boundary conditions – Applications to cylinders under internal or external pressures – Rotating discs		
UNIT – V	**Isoparametric Elements for Two Dimensional Continuum:**	**9**
Four node quadrilateral elements – Shape functions – Element stiffness matrix and force vector – Numerical integration - Stiffness integration – Stress calculations.		

Total: 45

REFERENCES:

1. Rao S.S., "The Finite Element Method in Engineering", 5th Edition, Butterworth-Heinemann, 2014.
2. Cook R.D., Malkus D.S., Plesha M.E. and Witt R.J., "Concepts and Applications of Finite Element Analysis", 4th Edition, John Wiley & Sons, 2007.
3. Reddy J.N., "An Introduction to the Finite Element Method", Tata McGraw Hill, International Edition, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the finite element concepts used for designing engineering components	Applying (K3)
CO2	derive the element matrix equation for solving one dimensional structural problems and solve for different applications	Analyzing (K4)
CO3	estimate the results for a 3D domain using simple two dimensional assumptions for different applications	Evaluating (K5)
CO4	solve and analyze the engineering problems using axisymmetric assumptions	Analyzing (K4)
CO5	apply the concepts of isoparametric elements and Numerical integration techniques in FEM	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	1	2
CO2	3	1	2
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	30			100
CAT2		20	40	40			100
CAT3		20	40	40			100
ESE	15	35	25	25			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME09 COMPOSITE MATERIALS

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	II	PE	3	0	0	3

Preamble :	This course is designed to impart the composite materials manufacturing process and its evaluation procedures for various applications.	
UNIT – I	**Basics of Fibers, Matrices and Composites:**	**9**
Basics of fibers, matrices and composites: Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic, Aramid and Natural fibers. Matrices – Polymer, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Fiber surface treatments, Fillers and Additives.		
UNIT – II	**Manufacturing:**	**9**
Bag molding – Compression molding – Pultrusion – Filament winding – Resin film infusion - Elastic reservoir molding - Tube rolling – Quality inspection methods. Processing of metal matrix composites (MMC) – Diffusion bonding – Stir casting – Squeeze casting.		
UNIT – III	**Performance:**	**9**
Static mechanical properties – Tensile, Flexural and Compressive -Fatigue and impact properties – Environmental effects – Long term properties, Fracture behavior- CT and SENB- Damage tolerance.		
UNIT – IV	**Mechanics**:	**9**
Fiber content, density and void content. Rule of mixture -Volume and mass fractions – Density - Void content, Evaluation of four elastic moduli based on strength of materials approach and semi-empirical model-Longitudinal Young‘s modulus-Transverse Young‘s modulus–Major Poisson‘s ratio-In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber-reinforced lamina–Laminates–Lamination theory.		
UNIT – V	**Design:**	**9**
Failure Predictions, Laminate Design Consideration-Design criteria-Design allowable -Design guidelines, Joint design-Bolted and Bonded Joints, Design Examples-Design of a tension member – Design of a compression member – Design of a beam-Design of a torsional member, Application of Finite element method (FEM) for design and analysis of laminated composites.		

Total: 45

REFERENCES:

1. Mallick P.K., “Fiber Reinforced Composites: Materials, Manufacturing and Design”, 3rd Edition, Taylor and Francis, 2008.
2. Mallick P.K., “Fiber Reinforced Composites: Materials, Manufacturing and Design”, 3rd Edition, Taylor and Francis, 2008.
3. Bhagwan D. Agarwal, Lawrence J. Broutman, Chandrashekhar K., “Analysis and Performance of Fiber Composites”, 4th Edition, John Wiley & Sons, New York, October 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the basics of fibers and its characteristics	Understanding (K2)
CO2	develop composite materials using various manufacturing techniques	Understanding (K2)
CO3	assess the various properties of composite materials	Applying (K3)
CO4	model and evaluate the composite materials and its characteristics	Applying (K3)
CO5	create the design patterns for manufacturing of composites	Analyizing (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	1	2
CO2	3	1	2
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	40	40				100
CAT3	10	40	30	20			100
ESE	10	40	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME10 MACHINE TOOL CONTROL AND CONDITION MONITORING

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	III	PC	3	0	0	3

Preamble:	This course impart the knowledge in machine tool control and condition monitoring in a mechatronics perspective.	
UNIT – I	**Overview of Automatic Control in Machine Tools**	**9**
Open loop and closed loop system in machine tools- process model formulation-transfer function. Control actions-block diagram representation of mechanical pneumatic and electrical systems. Process computer -Peripherals-Data logger-Direct digital control-Supervisory computer control.		
UNIT – II	**Adaptive Control and PLC**	**9**
Adaptive control-types – ACC, ACO, Real time parameter estimation, Applications- adaptive control for turning, milling, grinding and EDM. Programmable logic controller-Functions-Applications in machine tools-Macro programming for tool life monitoring and Management		
UNIT – III	**Condition Monitoring**	**9**
Introduction – Cost comparison with and without CM – On-load testing and offload testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis		
UNIT – IV	**Vibration, Acoustic Emission and Sound Monitoring**	**9**
Primary & Secondary signals, Online and Off -line monitoring. Fundamentals of Vibration, Sound, Acoustic Emission. Machine Tool Condition Monitoring through Vibration, Sound, Acoustic Emission, Case Studies.		
UNIT – V	**Condition Monitoring, Through Other Techniques**	**9**
Visual & temperature monitoring, Leakage monitoring, Lubricant monitoring, condition monitoring of Lube and Hydraulic systems, Thickness monitoring, Image processing techniques in condition monitoring.		

Total: 45

REFERENCES:

1. Mishra R.C., Pathak K., "Maintenance Engineering and Management", 2nd Edition, Prentice Hall of India Pvt. Ltd., 2016
2. Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing" Pearson Education India, 2016
3. Robert Bond Randall – Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	summarize the concepts of automatic control in machine tools	Understanding (K2)
CO2	choose the type of adaptive control and PLC for machining operations	Applying (K3)
CO3	explain the concepts of condition monitoring techniques	Understanding (K2)
CO4	select the condition monitoring technique for the machine tool among vibration, acoustic emission and sound analysis	Applying (K3)
CO5	select appropriate condition monitoring technique for machine tool control applications	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	1	2
CO2	3	2	2
CO3	3	2	3
CO4	3	2	3
CO5	2	3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**10**	**70**	**10**				
CAT2	**10**	**60**	**20**				
CAT3	**10**	**50**	**40**				
ESE	**10**	**60**	**30**				

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME11 INDUSTRIAL DATA COMMUNICATION

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	III	PC	3	0	0	3

Preamble:	This course enable the graduates to understand the data networks, communication protocols and modes of industrial automation.	
UNIT – I	**Introduction to Networks in Industrial Automation:**	**9**
Information flow requirements – Hierarchical communication model – network requirements - Data Communication basics – OSI reference model – Industry network – recent network.		
UNIT – II	**Data Network Fundamentals:**	**9**
EIA 232 interface standard – EIA 485 interface standard – EIA 422 interface standard – Current loop and serial interface converters – Data link control protocol – Media access protocol: Command/response – Token passing and CSMA/CD – TCP/IP – Bridges – Routers – Gateways –Standard ETHERNET Configuration.		
UNIT – III	**HART and MODBUS Protocol:**	**9**
Introduction – Evolution of signal standard – HART communication protocol – Communication modes – HART Networks– HART commands – HART applications – MODBUS protocol structure –transmission modes – function codes – troubleshooting.		
UNIT – IV	**Fieldbus and Profibus:**	**9**
Introduction - General Fieldbus architecture, basic requirements of Fieldbus standard, Fieldbus topology, Interoperability and Interchangeability. **Profibus**: Introduction, Profibus protocol stack, Profibus communication model, Communication objects, System operation and Troubleshooting – Foundation fieldbus versus Profibus.		
UNIT – V	**AS-interface (AS-i), Devicenet and Industrial Ethernet: AS interface**:	**9**
Introduction, Physical layer, Data link layer and Operating characteristics. **Devicenet**: Introduction, Physical layer, Data link layer and Application layer. **Industrial Ethernet:** Introduction – core elements of Ethernet, Ethernet frame format, topology overview- Overview of Ethernet versions – 10Base Ethernet and 100Base Ethernet.		

Total: 45

REFERENCES:

1. Bela G. Liptak and HalitEren, “Instrument Engineers Handbook: Process Software and Digital Networks”, Volume 3, 4th Edition, CRS Press, 2011.
2. Mackay S., Wright E., Reynders D. and Park J., “Practical Industrial Data Networks: Design, Installation and Troubleshooting”, Newnes Publication, Elsevier, 2004.
3. Berge J., “Field Buses for Process Control: Engineering, Operation, and Maintenance”, ISA Press, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the basic network requirements for Industrial automation	Understanding (K2)
CO2	infer the data network fundamentals	Understanding (K2)
CO3	infer the HART and MODBUS Protocol for Networked Industrial Automation	Understanding (K2)
CO4	recommend the FIELDBUS AND PROFIBUS for industrial automation network	Understanding (K2)
CO5	realize the functions of AS-I, Devicenet and Ethernet in industrial network	Apply (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	2	2	3
CO2	3	2	3
CO3	1	2	3
CO4	1	2	3
CO5	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	80					
CAT2	20	80					
CAT3	10	70	20				
ESE	10	70	20				

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME12 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	III	PC	3	0	0	3

Preamble:	This course provides basic knowledge about Artificial Intelligence and its applications and different types of machine learning and their implementation for real world problems	
UNIT – I	**Intelligent Agents:**	**9**
Concept of Rationality, Environments and Structure. Solving Problems by Searching: Problem-Solving Agents, Example, Searching for Solutions, Search Strategies and constraint Satisfaction Problems		
UNIT – II	**Logical Agents:**	**9**
Knowledge-Based Agents, Wumpus World, Propositional Logic, Propositional Theorem. **First-Order Logic:** Representation, Syntax and Semantics, Using First-Order Logic and Knowledge Engineering. **Inference in First-Order Logic:** Unification and Lifting, Forward and Backward Chaining, Resolution.		
UNIT – III	**Introduction to Machine Learning:**	**9**
Machine Learning Applications - Types of Machine learning **-Supervised Learning:** Building good training sets – Data Pre-processing - Decision tree learning. Bayesian Decision Theory: Introduction – Classification.		
UNIT – IV	**Artificial Neural Networks:**	**9**
Introduction – Representations – Problems – Perceptron – Multilayer network and Back Propagation Algorithm. **Unsupervised Learning:** K-Means clustering - Hierarchical clustering.		
UNIT – V	**Reinforcement Learning:**	**9**
Single state case – Elements – Model based learning –Temporal difference learning – Generalization.		

Total: 45

REFERENCES:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd Edition, Pearson Education, 2016.
2. Ethem Alpaydin, “Introduction to Machine Learning”, 3rd Edition, Prentice Hall India, 2015.
3. Sebastian Raschka,”Python Machine Learning”, 3rd Edition, Packt Publishing, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Define intelligent agents and apply searching for solving problems	K2
CO2	Apply propositional and first order logic in AI	K3
CO3	Utilize supervised learning methods to solve real world problems	K3
CO4	Design solutions for the given problem using artificial neural networks and unsupervised learning methods	K3
CO5	Recognize the need of reinforcement learning in AI applications	K2

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	2	2
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	20	40	40				100
CAT3	10	40	50				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME13 MACHINE VISION SYSTEM

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Virtual Instrumentation	IV	PE	3	0	0	3

Preamble :	This course provides the practical knowledge about the various components of machine vision systems and image processing techniques.	
UNIT – I	**Processing of Information in the Human Visual System:**	**9**
Design and structure of eye– Adaptation to different light level– Rod and Cone Responses. **Introduction to Building a Machine Vision Inspection:** Specification– Part Presentation– Performance requirement– Information Interfaces– Installation Space– Environment.		
UNIT – II	**Designing a Machine Vision System:**	**9**
Camera types– Field view– Resolution: camera sensor resolution, Spatial resolution, Measurement of accuracy, Calculation of resolution, Resolution for a Line Scan Camera - Choice of camera, Frame grabber and hardware platform– Pixel rate– Lens design - digital and smart cameras.		
UNIT – III	**Lighting System:**	**9**
Demands on machine vision lighting – Light and light perception – Light sources for machine vision – Light Color and Part Color: Monochromatic light, white light, UV, IR and Polarized light – Light filters. **Camera Computer Interface:** Analog camera buses – Parallel digital camera buses– Standard PC buses – Computer buses.		
UNIT – IV	**Image Processing Fundamentals:**	**9**
Introduction to Digital Image Processing - Image sampling and quantization - Image enhancement: Gray Value Transformations, Radiometric Calibration, Image Smoothing– Geometric transformation– Image segmentation– Object Recognition and Image Understanding - Feature extraction: Region Features, Gray Value Features, Contour Features–Morphology– Edge extraction– Fitting and Template matching.		
UNIT – V	**Applications and Case Studies**	**9**
Diameter Inspection of Rivets– Tubing Inspection– Machine Vision in Manufacturing– Glue Check under UV Light– Completeness Check of automotive control component– Multiple Position and Completeness Check of small hybrid circuit– Pin Type Verification– Type and Result Data Management of spark plugs– Robot Guidance.		

Total: 45

REFERENCES:

1. Alexander Hornberg, “Handbook of Machine Vision”, Wiley-VCH, 2006.
2. Davies E.K., “Machine Vision: Theory, Algorithms, Practicalities”, 3rd Edition, Elsevier, 2005.
3. Milan Sonka, “Image Processing Analysis and Machine Vision”, Vikas Publishing House, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the fundamental concepts of vision system	Understanding (K2)
CO2	choose the components for designing the machine vision system	Understanding (K2)
CO3	learn about the concept of lighting system and various computer interfaces	Understanding (K2)
CO4	identify the concept of image processing techniques	Applying (K3)
CO5	analyze the machine vision system through real time applications	Analyzing (K4)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	1	2
CO2	3	1	2
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	80					100
CAT2	20	50	30				100
CAT3	20	60	20				100
ESE	20	55	25				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME14 PRODUCT DESIGN AND DEVELOPMENT

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	IV	PE	3	0	0	3

Preamble:	This course provides knowledge on new product planning, concept development, industrial design and prototype development	
UNIT – I	**Development Processes and Organizations**:	**9**
Introduction to New Product and Product design- Characteristics of successful product – The challenges in product development -Product development process – adapting generic product development process- Product development process flows –product development organizations.		
UNIT – II	**Opportunity Identification and Product Planning**:	**9**
Types of opportunities- Structure of Opportunity Identification – Opportunity identification process; Product Planning Process - Four types of product development projects – Steps in Product Planning- - Identifying Customer needs.		
UNIT – III	**Product specifications and Concept development:**	**9**
Product Specifications – Target and final specifications. Concept generation: Five step method- Concept selection- Concept screening – Concept scoring – concept testing.		
UNIT – IV	**Product architecture and Industrial Design**:	**9**
Implications of the architecture – Establishing the architecture – Delayed differentiation – Platform Planning – System level design issues. Industrial Design – Assessing the Need for Industrial Design and its impact - Industrial design process and management – Assessing the quality of Industrial Design.		
UNIT – V	**Design considerations and prototyping:**	**9**
Design for environment – Design for manufacturing and assembly; Prototyping – Principles – Technologies – planning for prototypes -Robust design – process flow.		

Total: 45

REFERENCES:

1.	Eppinger, S.D. and Ulrich, K.T. " Product design and development", 6th edition, McGraw-Hill Higher Education, 2016
2.	Devdas Shetty, "Product Design For Engineers", Cengage Learning, 2015.
3.	Maddock M. and Uriarte L., "Brand New: Solving the Innovation Paradox – How Great Brands Invent and Launch New Products, Services and Business Models", John Wiley & Sons, Inc., Hoboken, New Jersey, 2011.
4.	Roozenburg, N. F., & Eekels, J., "Product design: fundamentals and methods", John Wiley & Sons Inc, 1995.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the basic need for new product design and development process	Understanding (K2)
CO2	identify opportunities and customer needs for new product development	Applying (K3)
CO3	arrive at product specification and develop concepts for new product	Analysing (K4)
CO4	establish the overall product architecture and assess its industrial design	Analyzing (K4)
CO5	assess the design from environmental, manufacturing and assembly perspective and develop prototypes	Analyzing (K4)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	1	2
CO2	3	1	2
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	30			100
CAT2	10	30	30	30			100
CAT3	10	30	30	30			100
ESE	10	30	30	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME15 DRONE TECHNOLOGY

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Sensors and IOT, Bridge course mechanical and Industrial Robotics	IV	PE	3	0	0	3

Preamble:	This course strives to identify and introduce Drones or UAVs (unmanned aerial vehicles) as piloted by remote control or on board computers through computer vision and artificial intelligence technologies.	
UNIT – I	**Introduction to Unmanned Aerial Vehicles (UAV):**	**9**
Overview and background: history of UAVs, classifications of UAVs, lift generation method. Contemporary applications like military, government and civil areas. Operational considerations like liability / legal issues, ethical implications LOS / BLOS.		
UNIT – II	**Unmanned Aerial System (UAS) components:**	**9**
Platforms - configurations - characteristics – applications. Propulsion: internal combustion engines, turbine engines, electric systems. On-board flight control – Payloads: sensing/surveillance, weaponized UAS and delivery. Communications: command/control, telemetry. Launch/recovery systems - Ground control stations		
UNIT – III	**Basic Concepts of Flight:**	**9**
Aerodynamics: lift, weight, thrust, and drag. Flight performance: climbing vs. gliding flight, range / endurance - Stability and control: flight axes, flight controls, autopilots. Emergency identification and handling - Fixed wing operations: Types of fixed wing drones, make, parts, terminology and operation.		
UNIT – IV	**Drone Equipment Maintenance**:	**9**
Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Repair of equipment - Fault finding and rectification - Weather and meteorology.		
UNIT – V	**Regulatories and Regulations**:	**9**
Homeland regulatories: FCC, FAA and foreign regulatory. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations		

Total: 45

REFERENCES:

1. Paul Fahlstrom, Thomas Gleason, “Introduction to UAV Systems”, 4th edition, John Wiley & Sons, 2012.
2. Randal W. Beard and Timothy W. McLain, “Small Unmanned Aircraft: Theory and Practice“, Princeton University Press, 2010.
3. Jha, “Theory, Design, and Applications of Unmanned Aerial Vehicles”, CRC Press, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	acquire the basic knowledge about the development and potential of UAV in professional activities	Applying (K3)
CO2	interpret the features and characteristics of an Unmanned Aerial System	Applying (K3)
CO3	infer the basic concepts and features of flight	Applying (K3)
CO4	realize the drone equipment maintenance and repair	Applying (K3)
CO5	follow the Regulatory measures and regulations	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	1	3
CO2	3	1	3
CO3	3	1	3
CO4	3	1	3
CO5	3	1	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	30	10			100
CAT2	20	40	30	10			100
CAT3	10	40	30	20			100
ESE	10	40	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME16 AUTONOMOUS MOBILE ROBOTICS

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Robot Kinematics and Dynamics	IV	PC	3	0	2	4

Preamble :	This course strives to identify and introduce Drones or UAVs (unmanned aerial vehicles) as piloted by remote control or on board computers through computer vision and artificial intelligence technologies.	
UNIT – I	**Mobile Robot Kinematics:**	**9**
Introduction **-** Kinematic models and constraints – Manoeuvrability – Workspace – Motion control		
UNIT – II	**Locomotion:**	**9**
Introduction – Key issues for locomotion – Legged mobile robots – Wheeled mobile robots – Aerial mobile robots		
UNIT – III	**Perception:**	**9**
Introduction - Sensors for mobile robots – Fundamentals of computer vision and image processing – Feature extraction based on range data - Image feature extraction – Place recognition.		
UNIT – IV	**Localization:**	**9**
Introduction – Challenges of localization – Belief representation – Map representation – Probabilistic Map-Based localization – Autonomous map building.		
UNIT – V	**Planning and Navigation:**	**9**
Introduction – Competence for Navigation: Planning and Reacting – Path planning – Obstacle avoidance – Navigation architectures.		

List of Experiments:
1. Study of Fire Bird – V robot and its accessories.
2. Development of embedded programming for Buzzer interfacing using Fire Bird – V robot.
3. Development of embedded programming for LCD interfacing using Fire Bird – V robot.
4. Development of embedded programming for motion control using Fire Bird – V robot.
5. Development of embedded programming for position control using Fire Bird – V robot.
6. Development of embedded programming for velocity control using Fire Bird – V robot.
7. Development of embedded programming for ADC interfacing using Fire Bird – V robot.
8. Development of embedded programming for path planning using Fire Bird – V robot.
9. Development of embedded programming for obstacle avoidance using Fire Bird – V robot.
10. Development of embedded programming for wireless motion control of Fire Bird V robot using ZigBee Communication.
Lecture: 45, Practical: 15, Total: 60

REFERENCES:

1. Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, 2nd Edition, MIT Press, Cambridge, 2011.
2. Farbed Fahimi, “Autonomous Robots – Modeling, Path Planning and Control”, Springer, 2009.
3. Alonzo Kelly, “Mobile Robotics: Mathematics, Models and Methods”, Cambridge University Press, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	develop the kinematic model of mobile robots	Evaluating (K5)
CO2:	interpret the different concepts of locomotion	Applying (K3)
CO3:	select the sensory devices for environmental perception	Applying (K3)
CO4:	identify the techniques for localization	Applying (K3)
CO5:	apply the concepts of planning and navigation	Applying (K3)
CO6:	develop embedded programming for motion control	Applying (K3), Manipulation (S2)

CO7:	develop embedded programming for planning and navigation	Creating (K6), Precision (S3)
CO8:	develop embedded programming for wireless control	Creating (K6), Precision (S3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	2		3
CO2	2		3
CO3	2		3
CO4	2		3
CO5	2		3
CO6	3	2	3
CO7	3	2	3
CO8	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MME17 ADDITIVE MANUFACTURING

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	IV	PE	3	0	0	3

Preamble	This course provides scientific as well as technological aspects of various additive, and formative rapid manufacturing processes. Variety of applications also be covered ranging from rapid prototyping, rapid manufacturing to mass customization.	
UNIT – I	**Introduction to Additive Manufacturing:**	**9**
Evolution, fundamental fabrication processes, CAD for RPT, product design and rapid product development - Need for time compression in product development - Conceptual design - Detail design, Prototype fundamentals - Fundamentals of RP systems – RP process chain - 3D modelling -3D solid modeling software and their role in RPT - Data format - STL files- History of RP systems - Classification of RP systems - Benefits of RPT.		
UNIT – II	**Liquid based RP systems**:	**9**
Stereo Lithography Apparatus (SLA): Principle, Photo polymers, Post processes, Process parameters, Machine details, Advantages. Solid Ground Curing (SGC): Principle, Process parameters, Process details, Machine details, Limitations. Solid Creation System (SCS): Principle, Process parameters, Process details, Machine details, Applications.		
UNIT – III	**Solid based RP systems**:	**9**
Fusion Deposition Modeling (FDM): Principle, Raw materials, BASS, Water soluble support system, Process parameters, Machine details, Advantages and limitations. Laminated Object Manufacturing (LOM): Principle, Process parameters, Process details, Advantages and limitations. Solid Deposition Manufacturing (SDM): Principle, Process parameters, Process details, Machine details, Applications.		
UNIT – IV	**Powder based RP systems**:	**9**
Selective Laser Sintering (SLS): Principle, Process parameters, Process details, Machine details, Advantages and applications. 3-Dimensional Printers (3DP): Principle, Process parameters, Process details, Machine details, Advantages and limitations. Laser Engineered Net Shaping (LENS): Principle, Process details, Advantages and applications.		
UNIT – V	**Rapid Tooling and Applications of RP:**	**9**
Direct Rapid Tooling, Indirect Rapid Tooling: Soft tooling and Hard tooling. Applications of RP in Product design, Automotive industry, and Medical field – Conversion of CT/MRI scan data - Customized implant - Case studies - Reverse engineering.		

Total : 45

REFERENCES:

1. Chua.C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and Applications”, World scientific, Newjersy, 2010.
2. Pham D.T. and Dimov S.S, “Rapid Manufacturing”, Springer -Verlag, London, 2011.
3. Amitabha Ghosh, “Rapid Manufacturing a brief Introduction”, Affiliated East West Press, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the concepts of rapid prototyping in product design and development	Applying (K3)
CO2:	Select the suitable liquid based rapid prototyping system for a specific application	Applying (K3)
CO3:	select the suitable solid based rapid prototyping system for a specific application	Applying (K3)
CO4:	select the suitable powder based rapid prototyping system for a specific application	Applying (K3)
CO5:	apply the concepts of rapid prototyping in product design and development	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3	2	2
CO2	3	2	2
CO3	3	2	2
CO4	3	2	2
CO5	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	30	40	30				100
CAT3	30	45	25				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20GET13 INNOVATION AND BUSINESS MODEL DEVELOPMENT
(Common to ALL branches)

Programme & Branch	M.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	IV	PE	3	0	0	3

Preamble	This course will inspire the students to think innovation concepts and ideas for business model developments.	
UNIT – I	**Innovation and Design Thinking:**	**9**
Innovation and Creativity– Types of innovation – challenges in innovation- steps in innovation management- 7 concerns of design. Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping		
UNIT – II	**User Study and Contextual Enquiry:**	**9**
Explanatory research – primary and secondary data – classification of secondary data – sources of secondary data – qualitative research – focus groups – depth interviews – analysis of qualitative data – survey methods – observations- Process of identifying customer needs –organize needs into a hierarchy –establish relative importance of the needs- Establish target specifications		
UNIT – III	**Product Design:**	**9**
Techniques and tools for concept generation, concept evaluation – Product architecture –Minimum Viable Product (MVP)- Product prototyping – tools and techniques– overview of processes and materials – evaluation tools and techniques for user-product interaction		
UNIT – IV	**Business Model Canvas (BMC):**	**9**
Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies		
UNIT – V	**IPR and Commercialization:**	**9**
Need for Intellectual Property- Basic concepts - Different Types of IPs: Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design– Patent Licensing - Technology Commercialization – Innovation Marketing		

Total : 45

REFERENCES:

1. Jeanne Liedtka and Tim Ogilvie, “Designing for Growth: A Design Thinking Tool Kit for Managers”, Columbia University Press, 2011.
2. Eppinger, S.D. and Ulrich, K.T. “Product design and development”, 6th edition, McGraw-Hill Higher Education, 2016
3. Alexander Osterwalder, “Business model generation: A handbook for visionaries, game changers, and challengers”, 1st edition, John Wiley and Sons; 2010
4. Rajeev Surana “Protect Your Ideas”, Scinnovation Consultants Pvt. Ltd, 1st Edition, 2012
5. Indian Innovators Association, “Patent IPR Licensing – Technology Commercialization – Innovation Marketing: Guide Book for Researchers, Innovators”, Notion Press, Chennai, 2017

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	understand innovation need and design thinking phases	Understanding (K2)
CO2:	identify, screen and analyse ideas for new products based on customer needs	Analysing (K4)

CO3:	develop and analyse the concepts based on the customer needs and presents the overall architecture of the product	Analysing (K4)
CO4:	predict a structured business model for mvp	Applying (K3)
CO5:	Practice the procedures for protection of their ideas' IPR	Applying (K3)

Mapping of COs with POs			
COs/POs	**PO1**	**PO2**	**PO3**
CO1	3		2
CO2	3		2
CO3	3		2
CO4	3		2
CO5	3		1
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy			

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	30	40	30				100
CAT3	30	45	25				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**