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

- Provide value based quality education for the development of students as competent and responsible citizens.
- Contribute to the nation and beyond through research and development
- Continuously improve 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

2018 REGULATIONS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of M.E. Mechatronics Engineering will

PEO1: Design and develop Mechatronic products by integrating mechanical engineering, electronic control and system concepts

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

PEO3: Solve real world needs 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 UNDER REGULATION 2018

Curriculum Breakdown Structure (CBS)	Curriculum Content (% of total number of credits of the program)	Total number of contact hours	Total number of credits
Program Core (PC)	43	465	31
Program Electives (PE)	25	270	18
Humanities and Social Sciences and Management Studies (HSMS)	4.2	45	3
Project(s)/Internships (PR)/Others	27.8	600	20
		Total	**72**

KEC R2018: SCHEDULING OF COURSES – M.E. (Mechatronics Engineering)

Semester	Theory/ Theory cum Practical / Practical						Internship & Projects	Special Courses	Credits
	1	2	3	4	5	6	7	8	
I	18MMT11 Bridge Course Electronics / 18MMT12 Bridge Course Mechanical (PC-3-1-0-4)	18AMT12 Advanced Mathematics for Mechatronics (PC-3-1-0-4)	18MMT13 Sensors and Instrumentation (PC-3-0-0-3)	18MMC11 Computer Numerically Controlled Machines (PC-3-0-2-4)	18MMC12 Microcontroller and applications (PC-3-0-2-4)	18GET01 Introduction to Research (PC-3-0-0-3)			22
II	18MMC21 Robotics Engineering (PC-3-0-2-4)	18MMC22 Integrated Automation Controller (PC-3-0-2-4)	18MMC23 Control System Engineering (PC-3-0-2-4)	Elective-I (Professional) (PE-3-0-0-3)	Elective-II (Professional) (PE-3-0-0-3)	Elective-III (Professional) (PE-3-0-0-3)	18MMP21 Mini Project (PR-0-0-4-2)		23
III	Elective-IV (Professional) (PE-3-0-0-3)	Elective-V (Professional) (PE-3-0-0-3)	Elective-VI (Professional) (PE-3-0-0-3)				18MMP31 Project Work – Phase I (PR-0-0-12-6)		15
IV							18MMP41 Project Work – Phase II (PR-0-0-24-12)		12

Total Credits: 72

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M.E. DEGREE IN MECHATRONICS ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18MMT11/ 18MMT12	Bridge Course Electronics (or) Bridge Course Mechanical	3	1	0	4	50	50	100	PC
18AMT12	Advanced Mathematics for Mechatronics	3	1	0	4	50	50	100	PC
18MMT13	Sensors and Instrumentation	3	0	0	3	50	50	100	PC
18MMC11	Computer Numerically Controlled Machines	3	0	2	4	50	50	100	PC
18MMC12	Microcontroller and applications	3	0	2	4	50	50	100	PC
18GET01	Introduction to Research	3	0	0	3	50	50	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 2018-19 onwards)

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18MMC21	Robotics Engineering	3	0	2	4	50	50	100	PC
18MMC22	Integrated Automation Controller	3	0	2	4	50	50	100	PC
18MMC23	Control System Engineering	3	0	2	4	50	50	100	PC
	Elective - I	3	0	0	3	50	50	100	PE
	Elective - II	3	0	0	3	50	50	100	PE
	Elective - III	3	0	0	3	50	50	100	PE
	Practical								
18MMP21	Mini Project	0	0	4	2	100	0	100	PR
	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 2018-19 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
	Elective - IV	3	0	0	3	50	50	100	PE
	Elective - V	3	0	0	3	50	50	100	PE
	Elective - VI	3	0	0	3	50	50	100	PE
	Practical								
18MMP31	Project Work Phase I	0	0	12	6	50	50	100	PR
	Total				**15**				

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 2018-19 onwards)

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Practical								
18MMP41	Project Work Phase II	0	0	24	12	50	50	100	PR
	Total				**12**				

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 II						
18CCE02	Safety in Engineering Industry	3	0	0	3	PE
18MME01	Fluid Power System Design	3	0	2	4	PE
18MME02	Advanced Microcontrollers with IOT	3	0	2	4	PE
18MME03	Applied Finite Element Method	3	1	0	4	PE
18MME04	Factory Automation and CIM	3	0	0	3	PE
18MME05	Process Control Engineering	3	0	2	4	PE
18MME06	Metrology and Computer Aided Inspection	3	0	0	3	PE
18MME07	Applied Signal Processing	3	0	0	3	PE
18MME08	Virtual Instrumentation	3	0	2	4	PE
18MME09	Advanced Sensor Technology	3	0	0	3	PE
SEMESTER III						
18CCC11	Computer Applications in Design	3	0	2	4	PE
18CCE06	Modeling and Analysis of Manufacturing Systems	3	0	0	3	PE
18VLE12	Nature Inspired Optimization Techniques	3	0	0	3	PE
18COE13	Digital Image Processing and Multi Resolution Analysis	3	0	0	3	PE
18COE14	Industrial Data Communication	3	0	0	3	PE
18AEE11	Industrial Electronics	3	0	0	3	PE
18MSE17	Machine Learning	3	0	0	3	PE
18MWE12	Cyber Physical Systems	3	0	0	3	PE
18MME10	Mechatronics System Design and Control	3	0	2	4	PE
18MME11	Machine Vision System	3	0	2	4	PE
18MME12	Autonomous Mobile Robotics	3	0	2	4	PE
18MME13	MEMS Design	3	0	0	3	PE
18MME14	Machine Tool Control and Condition Monitoring	3	0	0	3	PE
18MME15	Bio Mechatronics	3	0	0	3	PE
18MME16	Additive Manufacturing	3	0	0	3	PE
18MME17	Automotive Electronics and Control	3	0	0	3	PE

18MMT11 BRIDGE COURSE ELECTRONICS

L	T	P	Credit
3	1	0	4

Preamble	To impart the knowledge on basic working principle and characteristics of electronic devices, electrical drives and special machines.
Prerequisites	Nil

UNIT – I **9**

Basic Electronics: 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 **9**

Bipolar Junction Transistor: 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 **9**

Operational Amplifiers and its Applications: 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 **9**

Power Electronics: 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 **9**

Electrical Drives and Special Machines: 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, Tutorial:15, Total: 60

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	Understanding (K2)
CO2:	identify the characteristics of BJT and OP-AMPs	Applying (K3)
CO3:	analyze the performance of OP-AMP and its applications	Analyzing (K4)
CO4:	infer the power electronic devices	Understanding (K2)
CO5:	explain the basics of electrical drives and special machines	Understanding (K2)

Mapping of COs with POs

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

18MMT12 BRIDGE COURSE MECHANICAL

L	T	P	Credit
3	1	0	4

Preamble	To impart knowledge of basic Mechanical Engineering concepts, mechanisms, design of machine elements and machine tools characteristics.
Prerequisites	Nil

UNIT – I **9**

Mechanisms: Kinematics – Links, pairs and mechanisms - 4 Bar mechanism – Crank rocker - Slider crank mechanisms – Inversions – Determination of Velocity and acceleration of simple mechanisms.

UNIT – II **9**

Friction: 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 **9**

Shafts, Gears and Gear Trains: Design of shafts –Couplings –Gears – law of gearing - Spur gear – Design of gears - Gear trains - simple and compound gear trains - determination of speed and torque in epicyclic gear trains.

UNIT – IV **9**

Vibration: Single degree of freedom systems – Forced, damped vibrations – System response time constant –Vibration isolation – Torsional vibrations – Two/ Three rotor systems – torsionally equivalent system.

UNIT – V **9**

Machine Tools: Machine tool construction features and operations: lathe, milling machine, drilling machine – Drive system for machine tools – mechanical, hydraulic and electric- stepped and variable speeds – spindle speeds and feed drives – Additive Manufacturing (Basics only) – 3D printer machine building for FDM technology.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Shigley, J.E., Pennock, G.R. and Uicker, J.J., “Theory of Machines and Mechanisms”, McGraw-Hill Inc., 2010.
2. Budyna,R.G. and Nisbett.K.J., “Shigley’s Mechanical Engineering Design” Mcgraw Hill International Edition, 2014.
3. Kalpakjian,S. and Schmid,S., “Manufacturing Processes for Engineering Materials”, 6th Edition, Pearson, Prentice Hall, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	determine the velocity and acceleration for rigid links in four bar and slider crank mechanisms	Analyzing (K4)
CO2:	evaluate the influence of friction behavior in mechanical elements like bearings, clutches, brakes and belt drives	Analyzing (K4)
CO3:	design a mechanical system with shafts, couplings, gears and gear drives with realistic constraints	Analyzing (K4)
CO4:	assess the effect of vibrations in linear and torsional systems	Analyzing (K4)
CO5:	interpret the various machine tools and drive mechanisms for subtractive and additive processes	Understanding (K2)

Mapping of COs with POs

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

18AMT12 ADVANCED MATHEMATICS FOR MECHATRONICS

L	T	P	Credit
3	1	0	4

Preamble	This course will help the students to identify, formulate and solve problems in mechatronics engineering using various mathematical tools
Prerequisites	Calculus, Matrices and Laplace Transform.

UNIT – I **9**

Linear Algebra: Vector spaces – Subspaces – Span – Linear independence – Basis and Dimension – Linear Transformation, Matrix of Linear Transformation – Dimension theorem (Statement only).

UNIT – II **9**

Calculus of Variation: Concept of variation – Euler equation – Variational problems with fixed boundaries – Variational problems involving several unknown functions – Functional involving first and second order derivates – Functional involving several independent variables – Isoperimetric problems – Direct methods – Rayleigh-Ritz method – Kantorowich method.

UNIT – III **9**

Graph Theory: Introduction of graphs – Isomorphism – Subgraphs – Walks, paths and circuits – Connected graphs – Eulerian Graphs – Hamiltonian Paths and circuits – Digraph –Some types of digraphs – Connectedness – Adjacency matrix and incidence matrix of graphs – Shortest path algorithms – Dijkstra's algorithm – Warshall's algorithm – Trees – Properties of trees – Spanning trees – Minimal spanning trees – Prim's Algorithm – Kruskal's algorithm.

UNIT – IV **9**

Laplace Transform Methods: Solution of initial and boundary value problems – Characteristics – Canonical forms – D'Alembert's Solution – Laplace transform methods – Displacement in a long string – Solution of Diffusion equation.

UNIT – V **9**

Eigen Value and Boundary Value Problems: Eigen value problems: Power method - Inverse power method - Faddeev – Leverrier Method. Solution of boundary value problems: Introduction - Finite difference method - Shooting method - Weighted Residual method - Cubic Spline method.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Stephen Andrilli and David Hecker, "Elementary Linear Algebra", 4th Edition, Academic Press, USA, 2010.
2. Gupta A.S., "Calculus of Variations with Applications", 12th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2015.
3. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall, 2005.
4. Sankara Rao K., "Introduction to Partial Differential Equation", Prentice Hall of India, New Delhi, 2011.
5. Rajasekaran S., "Numerical Methods in Science and Engineering A Practical Approach", A.H.Wheeler and Company Pvt. Ltd., 1986.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply linear algebra concepts for solving engineering problems	Applying (K3)
CO2:	solve variational problems	Evaluating (K5)
CO3:	solve graph theory oriented problems in Mechatronics engineering	Applying (K3)
CO4:	solve wave and diffusion equations by Laplace transforms	Applying (K3)
CO5:	use various numerical techniques for finding Eigen values and solving boundary value problems	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	3
CO2	2	1	3
CO3	3	1	2
CO4	2	1	3
CO5	2	1	2

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

18MMT13 SENSORS AND INSTRUMENTATION

(Common to Mechatronics, Engineering Design and CAD/CAM Branches)

L	T	P	Credit
3	0	0	3

Preamble	To impart basic knowledge about sensors used to measure various physical quantities like resistance, pressure, flow, level, humidity and so on and convert them into electronic signals (digital or analog) that can be easily read by the user or any other instrument.
Prerequisites	Physics

UNIT – I **9**

Introduction to Measurement: Units and Standards - Instrument classification - Calibration techniques - Characteristics of Instruments - Static and dynamic - Classification of errors - Error analysis - Statistical methods - Uncertainty.

UNIT – II **9**

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 – III **9**

Electrical Transducers: Turbine flow meter, Electromagnetic flow meter - Hot wire anemometer - Ultrasonic Meter - Resistive transducers - Potentiometer - RTD - Thermistor - Thermocouple - Radiation Pyrometer.

UNIT – IV **9**

Force, Displacement, Magnetic and Digital Sensors: 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 – V **9**

Signal Conditioning and Data Acquisition: Need for Signal Conditioning - Amplification - Filtering - Sample and Holding - Data logging and Acquisition - Distributed Data Acquisition and control systems - Interface system and standards.

Total: 45

REFERENCES:

1. Doebelin E.O., “Measurement Systems – Applications and Design”, 6th Edition, Tata McGraw Hill, New Delhi, 2017.
2. Sawhney A.K., “A course in Electrical and Electronic Measurement and Instrumentation”, Dhanpat Rai and Co. Pvt. Ltd., New Delhi, 2017.
3. Beckwith, Marangoni and Lienhard, “Mechanical Measurements”, 6th Edition, Addison–Wesley, New York, 2009.
4. Roy Choudry D., and Sheil Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd., New Delhi, 2014.
5. Patranabis D., “Sensor and Actuators”, Prentice Hall of India, 2005.
6. Manabendra Bhuyan, “Intelligent Instrumentation: Principles and Applications”, CRC Press, Newyork, 2011.
7. Barney G.C.V., “Intelligent Instrumentation”, Prentice Hall of India Pvt. Ltd., New Delhi, 1988.

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 error analysis	Understanding (K2)
CO2:	categorize the different type of non-electrical transducers based on the applications	Applying (K3)
CO3:	correlate the different type of electrical transducers for various applications	Applying (K3)
CO4:	infer the role of sensors in evolving technologies	Understanding (K2)
CO5:	analyze the need for signal conditioning, filters and acquiring data in real time systems	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1	2	3
CO2	3	2	1
CO3	2	3	3
CO4	3	2	1
CO5	1	2	3

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

18MMC11 COMPUTER NUMERICALLY CONTROLLED MACHINES

(Common to Mechatronics, Engineering Design & CADCAM Branches)

L	T	P	Credit
3	0	2	4

Preamble	To impart the fundamental knowledge and programming concepts of CNC machines.
Prerequisites	Nil

UNIT – I **9**

Construction Features of CNC Machines: 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 **9**

Control Systems for CNC Machines and CAD/CAM Integration: 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 **9**

CNC Programming: 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 **9**

Tooling System and Management: 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 **9**

Economics of CNC Operations and Special Purpose CNC Machines: 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. CNC grinding machines, CNC bending machines - pipe bending, CNC turret Press, CNC EDM - Wire cut EDM, CNC ECM - Electrochemical grinding machines.

List of Exercises:

1. Study of G codes and M codes for machining centre and turning centre
2. Programming and machining of given component using HMT VMC 200T
3. Programming and machining of given component using HMT CNC T70
4. Programming and machining of given component using CNC turning centre
5. Programming and simulation of given component using MASTER CAM (Lathe)

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Michael Fitzpatrick N.E., and Arlington W.A., "Machining and CNC Technology", 3rd Edition, Mc Graw Hill Education, 2014.
2. Sehrawat M.S. and Narang J.S., "CNC Machines (Computer Numerical Control)", Dhanpat Rai and Co., Pvt. Ltd., New Delhi, 2014.
3. Alan Overby, "CNC Machining Handbook: Building, Programming and Implementation", The McGraw-Hill Companies Inc., 2011.
4. Adithan M. and Pabla B.S., "CNC Machines", 3rd Edition, New Age International (P) Ltd., 2010.
5. Madison J., "CNC Machining Handbook: Basic theory, Production data and Machining process", Industrial Press Inc., 2005.

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 processes	Creating (K6)
CO4:	select proper tooling systems and fixtures for holding the work piece	Applying (K3)
CO5:	infer the economic concepts of CNC machine and selection of special purpose CNC machine	Understanding (K2)
CO6:	develop CNC programming using different G codes and M codes	Applying (K3), Precision (S3)
CO7:	develop part program and perform machining in Turning Centre	Creating (K6), Precision (S3)
CO8:	develop part program and perform machining in Machining Centre	Creating (K6), Precision (S3)

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
CO6	3	3	3
CO7	3	3	3
CO8	3	3	3

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

18MMC12 MICROCONTROLLER AND APPLICATIONS

L	T	P	Credit
3	0	2	4

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.
Prerequisites	Nil

UNIT – I **9**

8051 Microcontroller: 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 **9**

8051 Embedded C Programming: 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 **9**

PIC Microcontrollers Architecture: PIC microcontroller overview and features - Harvard architecture - Pipelining – Architecture of PIC18-PinDescription-Memory organization: Program memory-Data Memory - Register Organization.

UNIT – IV **9**

PIC 18 Features: I/O Ports Timers Counters-Capture/ Compare - PWM- External Hardware Interrupts-USART-ADC-Interfacing to External memory.

UNIT – V **9**

PIC 18 Embedded C Programming: Addressing Modes - Instruction set-Simple Programs. I/O port programming - Timer/Counter programming - Serial communications Programming - ADC Programming - Application case studies.

List of Experiments:

1. Interfacing of switch , LED and seven segment LED
2. Interfacing of LCD
3. Interfacing of DC motor
4. Interfacing of stepper motor
5. Interfacing of pressure, temperature, proximity, level switch etc., for a given case study

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Mazidi Muhammad Ali and Mazidi Janice Gillispie, “The 8051 Microcontroller and Embedded Systems”, 2nd Edition, Pearson Education, 2009.
2. Mazidi Muhammad Ali, Mckinlay Rolin .D., and Causey Danny,“ PIC Microcontroller and Embedded Syster 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)
CO6:	develop hexa decimal code for a given application using embedded C programming software	Applying (K3), Precision (S3)
CO7:	debugg the embedded C coding using simulation software	Analyzing (K4), Precision (S3)
CO8:	interface microcontroller hardware with I/Os for a specific application	Analyzing (K4), Precision (S3)

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
CO6	3	2	3
CO7	3	2	3
CO8	3	2	3

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

18GET01 INTRODUCTION TO RESEARCH

(Common to Engineering and Technology Branches)

L	T	P	Credit
3	0	0	3

Preamble	To familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting. To disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.
Prerequisites	Nil

UNIT – I **9**

Concept of Research: 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 **9**

Research Methods and Journals: 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 **9**

Paper Writing and Research Tools: 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 **9**

Effective Technical Thesis Writing/Presentation: 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 **9**

Nature of Intellectual Property: 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 various stages in research/patenting 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 using latest tools in proper format	Creating (K6)
CO4:	select suitable journal and submit a research paper	Applying (K3)

Mapping of COs with POs

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

18MMC21 ROBOTICS ENGINEERING

(Common to Mechatronics, CADCAM & Control and Instrumentation Engineering branches)

L	T	P	Credit
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.
Prerequisites	Bridge Course Mechanical and Applied Mathematics for Mechatronics

UNIT – I **9**

Introduction: 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 **9**

Robot Kinematics: 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 **9**

Velocity and Static Force: 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 **9**

Robot Dynamics: 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 **9**

Robot Control: 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 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 / MANUALS / SOFTWARES:

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

18MMC22 INTEGRATED AUTOMATION CONTROLLER

L	T	P	Credit
3	0	2	4

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.
Prerequisites	Sensors and Instrumentation

UNIT – I **9**

Device Layer Components: 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 **9**

Programmable Logic Controller: 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 **9**

PLC Programming: 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 **9**

Networking of PLC and SCADA: 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 **9**

Distributed Control System and Case Studies: 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.

List of Experiments:

1. Introduction to ladder programming using software
2. Introduction to simulation/communication/HMI software for PLC programming
3. Construction of Ladder programming for Boolean, math, compare operations.
4. Logical testing of field devices such as, Pushbutton, selector switch, proximity sensor, Relay, Contactor etc., by using PLC.
5. Level process control using PLC.
6. Linear and sequential actuation of pneumatic cylinder with timer and counter functions.
7. Interfacing pneumatic cylinders with SCADA
8. Interfacing of AC drive with PLC

9. Interfacing of AC drive with PLC and SCADA.

10. Application case study

Lecture: 45, Practical: 30, Total: 75

REFERENCES / MANUALS / SOFTWARES:

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	Creating (K6)
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)
CO6:	build and simulate PLC programming for discrete and analog I/Os	Applying(K3), Precision (S3)
CO7:	develop PLC program and interface field I/Os for a provided application	Applying(K3), Precision (S3)
CO8:	develop a SCADA program and interface with PLC for a provided application	Creating (K6), Precision (S3)

Mapping of COs with POs

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

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

18MMC23 CONTROL SYSTEM ENGINEERING

L	T	P	Credit
3	0	2	4

Preamble	Control system is the collection of physical components connected together to serve a particular objective. Control system Engineering has become an integral part of modern manufacturing and industrial process.
Prerequisites	Applied Mathematics for Mechatronics

UNIT – I **9**

System Modeling: System concepts – Mathematical modeling: Electrical systems, Mechanical systems, Electro Mechanical systems – Electrical analogous for mechanical systems – Block diagram reduction techniques, Signal flow graph.

UNIT – II **9**

Time Response Analysis: 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 **9**

Frequency Response Analysis: Frequency domain specifications – Correlation between time and frequency domain specifications – Bode plot, Polar plot – Nyquist stability criterion – Constant M & N circles.

UNIT – IV **9**

Compensators Design: Realization of basic compensators – Cascade compensation in time domain and frequency domain –Design of Lag, Lead and Lag, Lead compensator using root locus.

UNIT – V **9**

State Space Analysis: Continuous and discrete time state variable theory – State space formulation – State space representation using physical variables, phase variables and canonical variables – Solution of state equations – Controllability - Observability.

List of Experiments:

1. Introduction to linear and non linear system
2. Digital simulation of second order linear system
3. Determination of Transfer Function Parameters for linear system
4. Effect of P, PI, PID Controller on a linear system model
5. Frequency Response of Second Order System
6. Stability Analysis of Linear Systems using Bode Plot
7. Stability Analysis of Linear Systems using Root Locus
8. Effect of Addition of Poles and Zeros on System Stability
9. Design of Compensators using MATLAB/LabVIEW
10. Design and implementation of simple controller for real time application

Lecture: 45, Practical:30, Total: 75

REFERENCES / MANUAL / SOFTWARES:

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)
CO6:	design and model second order linear system	Analyzing (K4), Precision (S3)
CO7:	analyze the stability of system using the compensation techniques	Analyzing (K4), Precision (S3)
CO8:	analyze controller design for the given application	Analyzing (K4), Precision (S3)

Mapping of COs with POs

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

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

18CCE02 SAFETY IN ENGINEERING INDUSTRY

(Common to CADCAM, Engineering Design & Mechatronics branches)

L	T	P	Credit
3	0	0	3

Preamble	The course deals with the study on hazards involved in performing several machining operations, safety precautions and guidelines to be followed while handling machines and industrial equipments utilizing safety devices for specified operations and types of guarding systems in machines for safe operation.
Prerequisites	Manufacturing Technology, Material Removal Processes, Thermal Engineering.

UNIT – I **9**

Safety in Metal Working Machinery and Wood Working Machines: General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

UNIT – II **9**

Principles of Machine Guarding: Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearing-presses- forgehammer – flywheels - shafts couplings-gears-sprockets wheels and chains- pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

UNIT – III **9**

Safety in Welding and Gas Cutting: Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases - colour coding – flashback arrestor – leak detection - pipe line safety - storage and handling of gas cylinders.

UNIT – IV **9**

Safety in Cold Forming and Hot Working of Metals: Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes , hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.

UNIT – V **9**

Safety in Finishing, Inspection and Testing: Heat treatment operations, electro plating, paint shops, sand and shot lasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry- industrial waste disposal.

Total: 45

REFERENCES:

1. John V. Grimaldi and Rollin H. Simonds, “Safety Management”, 5th Edition, All India Travelers Book Seller, New Delhi, 1991.
2. Krishnan N.V., “Safety Management in Industry”, Jaico Publishers, 1996.
3. Jane Blunt, Nigel C. Balchin, “Health and Safety in Welding and Allied Processes”, 5th Edition, Woodhead Publishing Ltd., U.K., 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	work safely in metal and wood working machines	Applying (K3)
CO2:	identify proper guarding for different applications	Analyzing (K4)
CO3:	work safely in welding and allied process	Analyzing (K4)
CO4:	work safely in cold and hot working metals	Applying (K3)
CO5:	handle safely testing and inspection instruments	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1	2	1
CO2	1	2	2
CO3	1	2	1
CO4	1	2	1
CO5	2	2	1

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

18MME01 FLUID POWER SYSTEM DESIGN

(Common to Mechatronics, Engineering Design & CADCAM branches)

L	T	P	Credit
3	0	2	4

Preamble	This course deals with the design of a system which generate, control and transmission of power using pressurized fluids.
Prerequisites	Nil

UNIT – I **9**

Fundamentals and Power Source of Hydraulic System: 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 **9**

Control Components of Hydraulic System: 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 **9**

Fundamentals of Pneumatic System: 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 **9**

Fluid Power Circuit Design: 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 **9**

Industrial Circuits and Maintenance: 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 Experiments:

1. Design and testing of Electro-hydraulic circuit with pressure sequence valve
2. Design of hydraulic circuit for speed control of hydraulic motor and cylinder
3. Circuits with logic controls – AND valve and OR valve
4. Sequential Circuit with pneumatic control without pneumatic timers
5. Sequential Circuit with pneumatic control with pneumatic timers
6. Cylinder synchronizing circuits

7. Circuits with multiple cylinder sequence – Electrical control
8. Circuit with rod less cylinder – Electrical control
9. Proportional and Servo control of Pressure and Flow in hydraulic Circuits
10. Simulation and analysis of fluid power circuits using fluid power simulation software

Lecture: 45, Practical: 30, Total: 75

REFERENCES / MANUALS / SOFTWARES:

1. Esposito Anthony, "Fluid Power with Applications", 7th Edition, Pearson Education Ltd., New York, 2013.
2. Majumdar S.R., "Pneumatic Systems – Principles and Maintenance", 1st Edition, McGraw-Hill, New Delhi, 2017.
3. Majumdar S.R., "Oil Hydraulic Systems – Principles and Maintenance", 28th Edition, McGraw-Hill, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify the fluid power components, their symbols and functions	Applying (K3)
CO2:	select the required fluid power control components for a given application	Applying (K3)
CO3:	apply the pneumatic technology to design a system with low cost automation	Analyzing (K4)
CO4:	design and develop a fluid power circuit with different methodologies for an industrial environment	Creating (K6)
CO5:	design and analyze the fluid power circuit for a given application using simulation software	Creating (K6)
CO6:	identify the fluid power components and their symbols used in industry	Applying (K3), Manipulation (S2)
CO7:	design, construct and test fluid power circuits with pneumatic, electrical, PLC and logic control for low cost automation	Creating (K6), Precision (S3)
CO8:	develop and simulate fluid power circuit using simulation software for industrial application	Creating (K6), Precision (S3)

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
CO6	3	3	3
CO7	3	3	3
CO8	3	3	3

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

18MME02 ADVANCED MICROCONTROLLERS WITH IOT

L	T	P	Credit
3	0	2	4

Preamble	This course provides detailed architecture about ATMEGA microcontroller, programming, IoT, Raspberry Pi and Arduino which are powerful tools providing improved solutions optimized around the global market.
Prerequisites	Microcontroller and Applications

UNIT 1 **9**

ATMEGA 8 Microcontroller: Architecture of ATMEGA 8 – Pin Description–. Memory organization: Program memory – Data Memory - I/O Ports – Timers – Counters – Analog comparator – Serial Peripheral Interface – USART – External Hardware Interrupts – ADC.

UNIT II **9**

ATMEGA 8 Embedded C Programming: I/O ports: Register configuration–programming – Timers: modes–programming – Counters – ADC: configuration registers–programming – External Hardware Interrupts: types –programming.

UNIT III **9**

Introduction to IoT: Definition and characteristics –Physical System – Cyber Physical System – Layers of IoT – Levels of IoT – Networking Topologies and Communication Protocols(CoAP, 6LoWPAN, REST, MQTT, HTTP).

UNIT IV **9**

Microcontroller for real time applications: Embedded C programming for interfacing switch, LED, seven segment LED, Buzzer, analog sensors, solenoid valves, motors for real time case studies.

UNIT V **9**

Microcontroller and IoT for real time applications: Decentralized monitoring and control, data retrieval using microcontroller, data communication, data storage and data analytics. Case studies: pressure, level and temperature monitoring and control.

List of Experiments:

1. Introduction to microcontroller programming software for ATMEGA microcontroller programming
2. Introduction to Arduino microcontroller programming software
3. Interfacing Switch/LED with ATMEGA 8 Microcontroller - Simulation
4. Interfacing 7 Segment with ATMEGA 8 Microcontroller - Simulation
5. Programming with timers in ATMEGA 8 Microcontroller - Simulation
6. Programming with Arduino Microcontroller with IoT
7. Interfacing Raspberry-pi with Arduino and IoT
8. Case study- Application specific using Arduino and IoT
9. Case study- Application specific using Arduino and IoT
10. Case study- Application specific using Arduino and IoT

Lecture: 45, Practical: 30, Total: 75

REFERENCES / MANUAL / SOFTWARES:

1.	Valvano Jonathan W., "Embedded Microcomputer Systems: Real Time Interfacing", 3rd Edition, Thomson Asia, Singapore, 2011.
2.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on Approach", 1st Edition, Orient Blackswan Pvt. Ltd., New Delhi, 2015.
3.	Data sheet – ATMEGA 8.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	interpret architecture and features of ATMEGA 8 microcontroller	Understanding (K2)
CO2:	build embedded programming using ATMEGA 8 microcontroller	Applying (K3)
CO3:	comprehend the significance and applications of IOT	Understanding (K2)
CO4:	provide IOT based solutions using Raspberry pi development board	Evaluating (K5)
CO5:	develop a control system with Arduino board	Creating (K6)
CO6:	develop embedded C programming using Arduino microcontroller	Applying (K3), Precision (S3)
CO7:	build communication link between microcontroller and IoT hardware	Applying (K3), Precision (S3)
CO8:	provide solution for remote monitoring and control using microcontroller and IoT	Creating (K6), Precision (S3)

Mapping of COs with POs

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

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

18MME03 APPLIED FINITE ELEMENT METHOD

L	T	P	Credit
3	1	0	4

Preamble	This course provides basic concepts about FEM, discretization process, assembly, stiffness matrix and load vector for 1D & 2D problems.
Prerequisites	Strength of Materials

UNIT – I **9**

Introduction: 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 **9**

One Dimensional Elasticity Problems: 1-D Finite element modeling – Bar Element – Beam Element-Coordinates and shape functions – Assembly of stiffness matrix and load vector – Formulation of Element Matrices and Equations - Analysis of Truss and Beam problems – Applications to Heat Transfer problems.

UNIT – III **9**

Two-Dimensional Elasticity Problems: Introduction to 2-D Finite element modeling – Plane stress – Plane Strain – Displacement Equations – Element Matrices – Element Equations – Formulation using Natural Coordinates.

UNIT – IV **9**

Axisymmetric Elements: 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 **9**

Isoparametric Elements: Four node quadrilateral elements – Shape functions – Element stiffness matrix and force vector – Numerical integration - Stiffness integration – Stress calculations.

Lecture: 45, Tutorial: 15, Total: 60

REFERENCES:

1. Rao Singiresu S., “The Finite Element Method in Engineering”, 6th Edition, Butterworth-heinemann, 2017.
2. Reddy J.N., “An Introduction to the Finite Element Method”, 3rd Edition, McGraw Hill Edition, 2017.
3. Logan D.L., “A First Course in the Finite Element Method”, 6th Edition, Cengage Learning, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	explain the finite element concepts used for designing engineering components	Understanding (K2)
CO2:	derive the element matrix equation for solving one dimensional structural problems for different applications	Analyzing (K4)
CO3:	determine the results for a 3D domain using simple two-dimensional assumptions for different applications	Analyzing (K4)
CO4:	solve and analyze the 3D engineering problems using axisymmetric assumptions	Analyzing (K4)
CO5:	demonstrate the effective usage of isoparametric elements and Numerical integration techniques used in FEM	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		3
CO2	1	1	2
CO3	1	1	2
CO4	1	1	2
CO5	1		2

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

18MME04 FACTORY AUTOMATION AND CIM

(Common to Mechatronics and CAD/CAM branches)

L	T	P	Credit
3	0	0	3

Preamble	To impart fundamental knowledge about automation in the field of production and assembly lines.
Prerequisites	Nil

UNIT – I **9**

Automation: 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 **9**

Transfer Machines: 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 **9**

Manufacturing Systems: Components of Manufacturing system - Single station manufacturing cells, Manual assembly lines - Automated production lines - automated assembly systems.

UNIT – IV **9**

Cellular Manufacturing: Group technology – Part families – Parts classification and coding – Production flow analysis – Composite part concept – Machine cell design –FMS – Types – Components – Applications and benefits - Automatic data capture - Barcode technology – Radio frequency identification.

UNIT – V **9**

CAQC and Production Planning: 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). Material requirement Planning (MRP) - Structure of MRP - Inputs and Outputs of MRP - Manufacturing resource Planning (MRP II) – Enterprise Resource Planning (ERP) – Inventory control - statistical inventory control models.

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:	explain the types of manufacturing systems in manufacturing plants	Understanding (K2)
CO4:	identify the coding systems for different manufacturing parts and design flexible manufacturing systems for 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

18MME05 PROCESS CONTROL ENGINEERING

L	T	P	Credit
3	0	2	4

Preamble	This course covers basics of process control and the instrumentation used for it. The process control part includes introductory concepts, mathematical modeling, design and selection aspects of various control valves and its use for control purposes.
Prerequisites	Control System

UNIT – I **9**

Process Dynamics: Need for process control – Mathematical model of first order liquid level, Pressure and Thermal processes – Higher order process – Interacting and non-interacting systems- Continuous and Batch process – Self-regulation – Servo and regulator operation.

UNIT – II **9**

Basic Control Actions: Basic control actions – Characteristics of on-off, proportional, single-speed floating, Integral and Derivative control modes – P+I, P+D and P+I+D control modes – Electronic controllers. Evaluation criteria: IAE, ISE, ITAE and ¼ decay ratio.

UNIT – III **9**

Controller with Multiple Loops: Feed forward control – Ratio control – Selective control – Cascade control – Split range control – Inferential control – Predictive control – Adaptive control - Computer process interface for data acquisition and control – Computer control loops.

UNIT – IV **9**

Final Control Element: I/P converter – Pneumatic and electric actuators – Valve positioner – Control valves – Characteristics of control valves: Inherent and Installed characteristics. Valve body – Commercial valve bodies – Control valve sizing – Cavitation and flashing – Selection criteria.

UNIT – V **9**

Advanced Control Techniques: Introduction to stable and unstable process-Synthesis method – Pole placement method – Internal model control – Delay compensation – Model predictive control.

List of Experiments:

1. Response of Interacting systems
2. Response of non-interacting systems
3. Response of ON/OFF Control
4. Closed loop response of Flow Control System
5. Closed loop response of Level Control System
6. Closed loop response of Temperature Control System
7. Closed loop response of Pressure Control System
8. Tuning of PID Controller
9. Response of feed forward and feedback control system
10. Installed and Inherent characteristics of a control valve.

Lecture: 45, Practical: 30, Total:75

REFERENCES /MANUAL/ SOFTWARES:

1.	Stephanopoulos G., "Chemical Process Control", 1st Edition, Pearson Education, New Delhi, 2015.
2.	Seborg D.E., Mellichamp D.A., Edgar T.F. and Doyle III F.J., "Process Dynamics and Control", 2nd Edition, John Wiley and Sons, New York, 2010.
3.	Seborg D.E., Edgar T.F. and Mellichamp D.A., "Process Dynamics and Control", 3rd Edition, Wiley, New York, 2013.

COURSE OUTCOMES:

On completion of the course, the students will be able to

		BT Mapped (Highest Level)
CO1:	apply knowledge of mathematics, science, and engineering to the build and analyze models for flow, level, and thermal processes and second order process	Applying (K3)
CO2:	explain the control modes and features supported by the PID Controller	Applying (K3)
CO3:	infer the Multi-loop Control Schemes for industrial processes and computer control interfaces	Understanding (K2)
CO4:	inference the role of converters and explain the control valve characteristics and selection parameters of control valve	Applying (K3)
CO5:	apply the advanced control techniques and synthesis the stable and unstable process	Applying (K3)
CO6:	build mathematical model of real time processes	Creating (K6), Precision (S3)
CO7:	design controllers for real time processes	Applying (K3), Precision (S3)
CO8:	analyze the time domain specification of processes	Evaluating (K5), Precision (S3)

Mapping of COs with POs

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

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

18MME06 METROLOGY AND COMPUTER AIDED INSPECTION

(Common to Mechatronics and CADCAM branches)

L	T	P	Credit
3	0	0	3

Preamble	To make the learner to design and fabricate inspection methods and systems incorporating electronic systems for inspection and quality control in engineering.
Prerequisites	Sensors and Signal Processing

UNIT – I **9**

Linear and Angular Measurements: 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 **9**

Surface Finish and Form Measurement: 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 **9**

Laser Metrology: 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 **9**

Co-Ordinate Measuring Machines: 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 **9**

Image Processing and Machine Vision System: 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 / MANUAL/SOFTWARES:

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

18MME07 APPLIED SIGNAL PROCESSING

L	T	P	Credit
3	0	0	3

Preamble	To emphasize the significance of knowledge on signal processing.
Prerequisites	Nil

UNIT – I **9**

Sources of Signals: Generation and characteristics of Speech signals – Seismic signals – Radar, vibration, ultrasonic, pressure, strain, temperature signals - Bio signals (ECG, EEG, phonocardiogram and EMG).

UNIT – II **9**

Pre-Processing Signals: Noise sources and characteristics - Filters- IIR and FIR filters -Design of filters low pass, high pass, band pass, notch filter and chebshiv filters. Elliptic filters, butter worth filters – Kalman Filter- Adaptive filtering - Comb Filter- Denoising concepts.

UNIT – III **9**

Digital Signal Processing: Time series analysis –Time varying analysis - Time frequency representation - ARMA Signal modelling- FFT - Power spectral density estimation.

UNIT – IV **9**

Feature Extraction Methods: STFT – DFFT – sine and cosine transform – wavelet concept – Empirical Mode Decomposition (EMD) – Time frequency representation, spectrogram – Methods for extracting the parameters: Energy, Average Magnitude - Introduction to feature extraction and Classification.

UNIT – V **9**

Analysis and Application of Signal Processing: Cepstral analysis of speech signals– spectral analysis of bio signals and vibration signals- Radar signal processing for multiple sensor information- signal processing in affective state computation and brain computer interface – introduction to Fusion technique.

Total: 45

REFERENCES:

1. John G. Proakis and Dimitrisk Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", 4th Edition, Pearson Education Ltd., 2006.
2. Rangaraj M. Rangayyan, 'Biomedical Signal Analysis-A case study approach", 2nd Edition, Wiley, New York, 2016.
3. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing - A Practical Approach", 2nd Edition, Pearson Education Ltd., New Delhi, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the characteristics of different forms of signals	Understanding (K2)
CO2:	illustrate the use of filters for signals processing	Understanding (K2)
CO3:	analyze the techniques used for digital signal processing	Analyzing (K4)
CO4:	describe the various signal extraction methods	Applying (K3)
CO5:	evaluate the use of signal processing techniques for real time systems	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	3
CO2	2	1	3
CO3	3	2	3
CO4	2	1	3
CO5	3	2	3

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

18MMME08 VIRTUAL INSTRUMENTATION

L	T	P	Credit
3	0	2	4

Preamble	Virtual instrumentation is an interdisciplinary field that merges sensing, hardware and software technologies to create flexible and sophisticated instruments for control and monitoring applications.
Prerequisites	Sensors and Instrumentation

UNIT – I **9**

Introduction to Virtual Instrumentation: Historical perspective and traditional bench top instruments, Architecture of virtual instrument, Physical quantities and analog interfaces – Graphical User Interfaces and its relation to operating system. **Programming Fundamentals:** Front panel - Block diagram, Tools, Controls and Functions palette, Modular programming.

UNIT – II **9**

LabVIEW Programming Basics – I: VI and sub VI, Structures: FOR, WHILE, Case, Sequence and Event structures, Formula nodes, Expression nodes - Local and Global variables, Waveform- graph/chart operations.

UNIT – III **9**

LabVIEW Programming Basics – II: Arrays, Clusters, String functions, File I/O: Read/Write - Csv/Ini files – Time and Dialog control - Report generation and publishing measurement data in web.

UNIT – IV **9**

Data Acquisition System: Data Acquisition: Review of Transducer and Signal conditioning - DAQ hardware: DAQ assistant and configurations. Instrument control – TCP/IP, VISA modules – Instrument drivers - Serial port communication, Networking basics for office and industrial applications.

UNIT – V **9**

Applications of Virtual Instrumentation: Image processing: pattern matching and part inspection – Motion control – Control design and simulation: closed loop system analysis plot.

List of Experiments:

1. Develop graphical program in structures using FOR and WHILE operations.
2. Develop graphical program in String functions.
3. Develop graphical program in Case/Sequence structure operations.
4. Develop graphical programming using Array and Clusters.
5. Develop graphical program in Sub VI’s.
6. Develop graphical program in Formula node and Property node operations.
7. Develop graphical program using local and global variables.
8. Develop graphical program File Input / File Output function using Read / write file.
9. Develop graphical program for real time interface to measure physical variables.
10. Develop graphical programming in Machine vision/ Vision Assistant.

Lecture: 45, Practical: 30, Total: 75

REFERENCES / MANUAL / SOFTWARES:

1. Jeffery Travis and Jim Kring, “LabVIEW for Everyone: Graphical Programming Made Easy and Fun”, 3rd Edition, Pearson Education, India, 2009.
2. Wells L.K. and Travis J., “LabVIEW for Everyone”, 2nd Edition, Prentice Hall, New Delhi, 2009.
3. Mihure B., “LabVIEW for data acquisition”, Prentice Hall of India, New Delhi, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	illustrate the fundamentals of virtual instrumentation and its basic programming concepts	Understanding (K2)
CO2:	identify different tools in virtual instrumentation software	Understanding (K2)
CO3:	develop programming in graphical system design platform	Applying (K3)
CO4:	interface data acquisition system and measure real world physical parameters	Applying (K3)
CO5:	apply virtual instrumentation programming to solve industrial applications	Creating (K6)
CO6:	apply the VI tools in graphical programming	Applying (K3), Precision (S3)
CO7:	analyze real time data through data acquisition card	Analyzing (K4), Precision (S3)
CO8:	develop graphical programming for machine vision system	Applying (K3), Precision (S3)

Mapping of COs with POs

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

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

18MME09 ADVANCED SENSOR TECHNOLOGY

L	T	P	Credit
3	**0**	**0**	**3**

Preamble	This course equip the students to apply newly introduced techniques in sensor design and fabrication.
Prerequisites	Sensors and Instrumentation

UNIT – I **9**

Fundamentals of Physical Sensors: Introduction – Historical development of sensors – Sensor Characteristics and Terminology – Physical Effects Employed for Signal Transduction – Classification of sensors – New Sensor Materials and Technologies.

UNIT – II **9**

Chemical and Optical Sensors: Principle of Semiconductor Sensors – Thickness-Shear-Mode (TSM) Resonators – Surface Acoustic Wave Sensors – Amperometric Sensors – Conductometric Sensors: Chemiresistors – Capacitive pH Sensors – Ion Channel Sensors – Organic Field-Effect Transistors. Optical Sensors: Introduction – Corpuscular Properties of Light: Lambert–Beer Law – Luminescence – Light Polarization – Light Scattering – Characteristics of optical sensors – Fiber Optic Sensors Based upon the Fabry–Perot Interferometer – Polarimetric Optical Fiber Sensors – In-Fiber Grating Optic Sensors – Distributed Fiber Optic Sensors.

UNIT – III **9**

Magnetic Sensors: Hall sensors – AMR sensors – GMR sensors – Induction and fluxgate sensors – Resonance sensors – Magnetic position sensors – Contactless current sensors.

UNIT – IV **9**

Advanced Sensor Design: Fluoroscopic machines design, Nuclear medical systems, EMI to biomedical sensors, types and sources of EMI, Fields, EMI effects. Laser Gyroscope and accelerometers.

UNIT – V **9**

Wireless Sensor Networks: Introduction to Wireless Sensor Networks – Individual Wireless Sensor Node Architecture – Wireless Sensor Networks Architecture – Inter layer Communication – Power Consideration in Wireless Sensor Networks – Applications of Wireless Sensor Networks - disaster management.

Total: 45

REFERENCES:

1. John Vetelino and Aravind Reghu, “Introduction to Sensors”, CRC Press-Taylor and Francis Group, New York, 2017.
2. Jacob Fraden, “Handbook of Modern Sensors”, 5th Edition, Springer, New York, 2015.
3. Yin S., Ruffin P.B. and Yu Francis T.S., “Fiber Optic Sensors”, 2nd Edition, CRC Press-Taylor and Francis Group, New York, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	categorize the physical principles behind signal transduction	Analyzing (K4)
CO2:	correlate the chemical properties of materials in identifying new solutions	Analyzing (K4)
CO3:	evaluate techniques adopted in magnetic measurements	Evaluating (K5)
CO4:	choose appropriate sensor for given application	Applying (K3)
CO5:	analyze the concepts of wireless sensor network	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	2
CO2	2	1	1
CO3	3	1	3
CO4	3	2	3
CO5	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy			

18CCC11 COMPUTER APPLICATIONS IN DESIGN

(Common to CADCAM & Mechatronics Branches)

(Approved Data book may be permitted)

L	T	P	Credit
3	0	2	4

Preamble	As modeling is inevitable in design process, the application of computer graphics and visual realism concepts are to be known. To develop models the knowledge on surface and solid modeling is mandatory. Basic knowledge on programming is needed to develop design program for mechanical components.
Prerequisites	Applied Mathematics, Engineering Drawing

UNIT – I **9**

Introduction to Computer Graphics: Design Process and CAD – Constraints – Computer graphics principles – Output primitives - Line and Circle drawing algorithms- Parametric equations (lines, circle) - 2 D and 3D transformation - Translation, scaling, rotation -Windowing, view ports - Clipping transformation.

UNIT – II **9**

Visual Realism and Curves: Hidden Line, Surface, Solid removal Algorithms - Shading - Coloring - RGB, HSV, HLS models - Introduction to curves - Analytical curves: line, circle and conics - Synthetic curves: Hermite cubic spline - Bezier curve and B-Spline curve - Curve manipulations.

UNIT – III **9**

Surface and Solid Modeling: Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated surface - Synthetic surfaces: Hermite bicubic surface - Bezier surface and B-Spline surface - Surface manipulations. Solid Modeling Techniques - Constructive Solid Geometry and Boundary Representation - Solid modeling systems - Parametric modeling - Creation of prismatic and revolved parts using solid modeling packages.

UNIT – IV **9**

Tolerance analysis and Mass property calculations: Assembly Modeling - Geometrical tolerance - Tolerance modeling and analysis - Mass property calculations - Curve length, Area, Volume, Mass, Moment of inertia - Mechanism simulation.

UNIT – V **9**

Computers in Design Productivity: Data Exchange formats - IGES, STEP - Reverse Engineering of components - Design optimization. Developing design programs using C for applications like design of shafts, gears etc.

List of Exercises / Experiments :

1. Creation of solid components by CSG and assemble the models to create a final assembly
2. Construction of solid models using parameters (variable quantities such as measurements) and editing the model by using its history
3. Creation of surfaces of desired shape by trimming, stitching and joining different surfaces to create a final shape model
4. Conversion of the real component into 3D CAD Model using measurement tools & CMM (coordinate measuring machine)
5. Development of design programs using C for applications like design of shafts and gears.

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Zeid Ibrahim, “Mastering CAD/CAM”, Tata McGraw Hill, New Delhi, 2007.
2. Hearn Donald and Baker M Pauline, “Computer Graphics”, C Version, Prentice Hall Inc., 2000.
3. Neumann William M. and Sproul Robert, “Principles of Interactive Computer Graphics”, McGraw-Hill Book Co., 2001.
4. Rao P.N., “CAD/CAM: Principles and Applications”, 3rd Edition, McGraw Hill, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	develop the output primitives and demonstrate transformations by applying the mathematical concepts behind computer graphic principles	Applying (K3)
CO2:	manipulate synthetic curves with mathematical concepts and illustrate visual realism techniques	Applying (K3)
CO3:	demonstrate surface and solid modeling techniques	Applying (K3)
CO4:	perform tolerance analysis and calculate geometrical and mass properties of a model	Evaluating (K5)
CO5:	write design programs using C/Auto LISP for shaft and gears	Applying (K3)
CO6:	model the solid components by CSG, B-rep and assemble the models to develop final assembly	Applying (K3), Precision(S3)
CO7:	develop surface models of desired shape by trimming, stitching and joining different surfaces to create a final shape model	Applying (K3), Precision(S3)
CO8:	convert the real component into 3D CAD model using measurement tools and CMM	Analyzing (K4), Precision(S3)

Mapping of COs with POs

COs/POs	3		2
CO1	3	2	2
CO2	2	2	1
CO3	2	2	3
CO4	2	2	2
CO5	2		3
CO6	2		3
CO7	3		2
CO8	3		2

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

18CCE06 MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS

(Common to CAD/CAM, Engineering Design & Mechatronics Branches)

L	T	P	Credit
3	0	0	3

Preamble	This course provides the knowledge of modeling analysis of manufacturing systems which ensures a very good performance.
Prerequisites	Industrial Engineering

UNIT – I **9**

Manufacturing Systems and Models: Types and principles of manufacturing systems, types and uses of manufacturing models, physical models, mathematical models, model uses, model building.

UNIT – II **9**

Material Flow Systems: Assembly lines-Reliable serial systems, approaches to line balancing, sequencing mixed models. Transfer lines and general serial systems-paced lines without buffers, unpaced lines. Shop scheduling with many products. Flexible manufacturing systems-system components, planning and control. Group technology-assigning machines to groups, assigning parts to machines. Facility layout-Quadratic assignments problem approach, graphic theoretic approach.

UNIT – III **9**

Supporting Components: Machine setup and operation sequencing-integrated assignment and sequencing. Material handling systems-conveyor analysis, AGV systems. Warehousing-storage and retrieval systems, order picking.

UNIT – IV **9**

Generic Modeling Approaches: Analytical queuing models, a single workstation, open networks, closed networks. Empirical simulation models-event models, process models, simulation system, example manufacturing system

UNIT – V **9**

Synchronization Manufacturing and Petri Nets: Synchronization Vs Optimization, defining the structure, identifying the constraint, exploitation, buffer management. Basic definitions-dynamics of Petri nets, transformation methods, event graphs, modeling of manufacturing systems

Total: 45

REFERENCES:

1. Ronald G. Askin, and Charles R. Standridge, "Modeling and Analysis of Manufacturing Systems", John Wiley & Sons, New York, 1993.
2. Mengchu Zhou, "Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach", World Scientific Publishing Co. Pte. Ltd., 2000.
3. Jean Marie Proth and XiaolanXie, "Petri Nets:A Tool for Design and Management of Manufacturing Systems", John Wiley & Sons, New York, 1996.
4. Brandimarte P. and Villa A., "Modeling Manufacturing Systems", Springer Verlag, Berlin, 1999.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	select the appropriate type of manufacturing system and model	Analyzing (K4)
CO2:	know about the assembly line transfer line and FMS	Understanding (K2)
CO3:	usage of various materials handling systems	Applying (K3)
CO4:	know the generic modeling systems	Understanding (K2)
CO5:	use the-theory of constraints for manufacturing a component	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	1	3
CO2	3	1	3
CO3	2	1	2
CO4	3	1	3
CO5	3	1	2

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

18VLE12 NATURE INSPIRED OPTIMIZATION TECHNIQUES

(Common to VLSI Design , Communication Systems, Embedded Systems, Computer Science and Engineering & Mechatronics branches)

L	T	P	Credit
3	0	0	3

Preamble	To acquaint and familiarize with different types of optimization techniques, solving optimization problems, implementing computational techniques, abstracting mathematical results and proofs etc.
Prerequisites	Linear algebra and Calculus

UNIT – I **9**

Introduction to Algorithms: Newton's Method – Optimization - Search for Optimality - No-Free-Lunch Theorems - Nature-Inspired Metaheuristics - Brief History of Metaheuristics. **Analysis of Algorithms:** Introduction - Analysis of Optimization Algorithms - Nature-Inspired Algorithms - Parameter Tuning and Parameter Control.

UNIT – II **9**

Simulated Annealing: Annealing and Boltzmann Distribution - Parameters - SA Algorithm - Unconstrained Optimization - Basic Convergence Properties - SA Behavior in Practice - Stochastic Tunneling. **Genetic Algorithms** : Introduction - Genetic Algorithms - Role of Genetic Operators - Choice of Parameters - GA Variants - Schema Theorem - Convergence Analysis

UNIT – III **9**

Particle Swarm Optimization: Swarm Intelligence - PSO Algorithm - Accelerated PSO – Implementation - Convergence Analysis - Binary PSO – Problems. **Cat Swarm Optimization:** Natural Process of the Cat Swarm - Optimization Algorithm – Flowchart - Performance of the CSO Algorithm.

UNIT – IV **9**

TLBO Algorithm: Introduction - Mapping a Classroom into the Teaching-Learning-Based optimization – Flowchart- Problems. **Cuckoo Search:** Cuckoo Life Style - Details of COA – flowchart - Cuckoos' Initial Residence Locations - Cuckoos' Egg Laying Approach - Cuckoos Immigration - Capabilities of COA. **Bat Algorithms:** Echolocation of Bats - Bat Algorithms – Implementation - Binary Bat Algorithms - Variants of the Bat Algorithm - Convergence Analysis.

UNIT – V **9**

Other Algorithms: Ant Algorithms - Bee-Inspired Algorithms - Harmony Search - Hybrid Algorithms.

Total: 45

REFERENCES:

1. Xin-She Yang, "Nature-Inspired Optimization Algorithms", 1st Edition, Elsevier, 2014.
2. Omid Bozorg-Haddad, "Advanced Optimization by Nature-Inspired Algorithms" Springer Volume 720, 2018.
3. Srikanta Patnaik, Xin-She Yang, Kazumi Nakamatsu, "Nature-Inspired Computing and Optimization Theory and Applications", Springer Series, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	infer the basic concepts of optimization techniques	Understanding (K2)
CO2:	identify the parameter which is to be optimized for an application	Analyzing (K4)
CO3:	analyze and develop mathematical model of different optimization algorithms	Analyzing (K4)
CO4:	select suitable optimization algorithm for a real time application	Applying (K3)
CO5:	recommend solutions, analyses, and limitations of models	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	1	1
CO2	3	1	3
CO3	3	2	3
CO4	3	1	3
CO5	3	1	3

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

18COE13 DIGITAL IMAGE PROCESSING AND MULTI RESOLUTION ANALYSIS

(Common to Communication Systems, Mechatronics, Information Technology & Applied Electronics branches)

L	T	P	Credit
3	**0**	**0**	**3**

Preamble	To analyze the images in frequency domain and to perform various operations like enhancement, Restoration, Compression, Registration and Multi resolution analysis.
Prerequisites	Digital Signal Processing

UNIT – I **9**

Image Transforms: Orthogonal transforms – FT, DST, DCT, Hartley, Walsh hadamard, Haar, Radon, Slant Wavelet, KL, SVD and their properties.

UNIT – II **9**

Image Enhancement and Restoration: Image enhancement - Point operations - contrast stretching - clipping and thresholding - digital negative intensity level slicing - bit extraction. Histogram processing - histogram equalisation -modification. Spatial operations – smoothing spatial filters, sharpening spatial filters. Transform operations. Color image enhancement. Image Restoration – degradation model, Noise models, Unconstrained and Constrained restoration, Inverse filtering – removal of blur caused by uniform linear motion, Wiener filtering, Restoration by SVD and Homomorphic filtering

UNIT – III **9**

Image Compression: Image Compression – Need for data compression – Run length encoding – Huffman coding – Arithmetic coding – predictive coding- transform based compression, - vector quantization – block truncation coding. Image Segmentation: Point, Edge and line detection -thresholding-Region based approach Image Representation: boundary based – region based and intensity based description

UNIT – IV **9**

Registration and Multivalued Image Processing: Registration – geometric transformation – registration by mutual information Mutivalued image processing – colour image processing – colour image enhancement-satellite image processing- radiometric correction – other errors- multi spectral image enhancement- medical image processing – image fusion.

UNIT – V **9**

Wavelets and Multiresolution Processing: Image Pyramids – Subband coding – The Haar Transform – Multiresolution Expansion – Series Expansion – Scaling Function – Wavelet Function – Wavelet Transform in One Dimension- The Wavelet Series Expansion – The Discrete Wavelet Transform – The Continuous Wavelet Transform – The Fast Wavelet Transform – Wavelet transform in two dimensions– Applications in image denoising and compression.

Total: 45

REFERENCES:

1. Gonzalez Rafel C. and Woods Richard E., “Digital Image Processing”, 4th Edition, Prentice Hall, New York, 2017.
2. Chanda B., Dutta Majumder D., “Digital Image Processing and Analysis”, 2nd Edition, PHI Learning, 2011.
3. Abdeljalil Ouahabi, “Signal and Image Multiresolution Analysis”, John Wiley & Sons, 2012.
4. Rosenfield Azriel and Kak Avinash C., “Digital Picture Processing”, 2nd Edition, Academic Press Inc., New York, 1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	implement the image enhancement and image restoration techniques	Applying (K3)
CO2:	model the systems to enhance and restore the image optimally	Applying (K3)
CO3:	apply the coding technique to perform compression of images	Applying (K3
CO4:	apply the concepts of registration to fuse images of various modalities	Applying (K3)
CO5:	analyze the images in one dimension and two dimension simultaneously	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	2
CO2	2	1	2
CO3	3	2	3
CO4	2	1	2
CO5	3	1	3

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

18COE14 INDUSTRIAL DATA COMMUNICATION

(Common to Communication Systems & Mechatronics branches)

L	T	P	Credit
3	0	0	3

Preamble	To appreciate industrial control protocol and layers involved in it and use suitable protocol for various conditioning methods
Prerequisites	Computer Communication Networks, Wireless Networks

UNIT – I **9**

Modbus: Modbus-Overview, protocol structure, Modbus troubleshooting – common problems-detailed troubleshooting: Modbus plus-protocol overview, common problems/faults-detailed troubleshooting. Modbus II-protocol architecture.

UNIT – II **9**

DNP 3 and IEC 60870-5: DNP 3-Overview, physical layer, data link layer, transport layer, application layer; IEC 60870-5 – standard-protocol architecture, physical layer, data link layer, application layer

UNIT – III **9**

Industrial Ethernet: 10Mbps Ethernet - Medium-access-control – signalling - Frame-format, transmission - reception. 802.2LLC- 100Mbps - Media-access – Autonegotiation – Industrial - Ethernet troubleshooting.

UNIT – IV **9**

AS-Interface and Devicenet: As-interface-overview, physical layer, data link layer-Device Net-physical layer, data link layer, application layer.

UNIT – V **9**

Data Highway Plus and HART: Data highway plus (DH 485)-overview; HART-protocol overview, physical layer, data link layer and application layer

Total: 45

REFERENCES:

1. Deon Reynders, Steve Mackay and Edvin Wright, "Practical Industrial Data Communication: Best Practice Technique", 1st Edition, Elsevier, 2005.
2. Deon Reynders, Steve Mackay and Edvin, "Practical Industrial Data Network Design and Installation", 1st Edition, Elsevier, 2004.
3. https://www.moxa.com/doc/man/Industrial_Protocols_Users_Guide_6e.pdf

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the concepts of Modbus used in modern data communication	Applying (K3)
CO2:	apply industry standard communication protocol for various conditioning methods	Applying (K3)
CO3:	analyze different Ethernet standards used in Industry	Analyzing (K4)
CO4:	examine need for AS-interface and its various layers	Analyzing (K4)
CO5:	implement Data Highway plus and HART protocol in industry	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1	1	1
CO2	2	1	2
CO3	3	1	3
CO4	3	2	3
CO5	2	1	2

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

18AEE11 INDUSTRIAL ELECTRONICS

(Common to Applied Electronics & Mechatronics branches)

L	T	P	Credit
3	0	0	3

Preamble	This course brings an overview of power converters and its applications towards industrial perspective. It also includes the various control and protection techniques for converters.
Prerequisites	Electron Devices, Electrical Machines, Power Electronics

UNIT – I **9**

Power Semiconductor Devices: Principle of operation and characteristics of power diodes, SCR, TRIAC, GTO, Power BJT, Power MOSFET and IGBT – Thyristor protection circuits.

UNIT – II **9**

Phase Controlled Rectifiers: Single phase half and full converters – Three phase half and full converters – Triggering circuits. Inverters: Single phase and three phase inverters – Types of PWM techniques: Sinusoidal PWM, modified sinusoidal PWM and multiple PWM.

UNIT – III **9**

DC-DC Converters: Chopper: Principle of operation – Step up and step down chopper – Control strategies – Voltage, Current and Load commutated chopper.

UNIT – IV **9**

AC-AC Converters: Principle of single phase AC voltage controller – Phase control – ON-OFF control. Cycloconverters: Step up and step down operation - Three phase to single phase and three phase to three phase cycloconverters - Introduction to Matrix Converters

UNIT-V **9**

Solid State DC and AC Drives: DC Drives: Conventional speed control methods for DC motors – DC motor control using rectifiers and choppers – AC drives: Conventional speed control methods for AC motors – Control of induction motor by Voltage, frequency, V/f and slip power recovery scheme. Speed control methods of single phase induction motors and synchronous motors.

Total: 45

REFERENCES:

1. Muhammad H. Rashid, "Power Electronics: Circuits Devices and Applications", 3rd Edition, Pearson Education, 2003.
2. Khanchandani K.B. and Singh M.D., "Power Electronics", 2nd Edition, Tata McGraw Hill Publishers, New Delhi, 2006.
3. Gopal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosa Book Distributors Pvt. Ltd, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	understand the operation and characteristics of basic power semiconductor devices	Understanding (K2)
CO2:	demonstrate the various PWM techniques for inverter and converter operations	Applying (K3)
CO3:	explicate the principle and operation of choppers	Understanding (K2)
CO4:	summarize the types and operation of AC-AC converters	Understanding (K2)
CO5:	experiment with various speed control methods with respect to industrial applications	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	2
CO2	2	1	2
CO3	2	1	3
CO4	2	1	2
CO5	2	1	2

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

18MSE17 MACHINE LEARNING

L	T	P	Credit
3	0	0	3

Preamble: Machine learning has a huge potential to improve products, processes and research. This course focuses on supervised machine learning algorithms to create simple, interpretable models to solve classification and regression problem.

Prerequisites: Linear Algebra, Calculus

UNIT – I **9**

Discriminative Algorithms: Cost function – LMS Algorithm – The normal Equations - Probability interpretation-locally weighted linear regression-logistic regression-generalized linear models-Application to prediction.

UNIT – II **9**

Generative Algorithms: Generative Models: Gaussian Discriminant Analysis (GDA)-Naïve Bayes- Laplace smoothing-Marginal classifier: Support Vector Machine (SVM) as optimal Margin Classifier-Application to Classification.

UNIT – III **9**

Neural Networks: ANN Architecture- Parameter Initialization -Forward Propagation- Activation Functions (Sigmoid, tanh, relu)-Training and Optimization with back propagation-Learning Boolean Functions.

UNIT – IV **9**

Convolutional Neural Networks (CNN): Convolution kernel-Pooling (Max Pooling, fractional Pooling)-Strides-Fully Connected Layers – Loss functions – MiniBatch Training – Optimization – Application to MNIST image classification.

UNIT – V **9**

Error Analysis: Regularization: Bias-Variance – Bias-variance Trade off – Initialization of parameters (Xavier) – Cross Validation – Data Augmentation – dropouts – Batch Normalization.

Total: 45

REFERENCES:

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning" Reprint, Springer-Verlag, New York. 2010.
2. Trevor Hastie, "The Elements of Statistical Learning", Springer, 2013.
3. UCI Machine Learning repository: http://archive.ics.uci.edu/ml/index.php

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	analyze and apply discriminative algorithms for classification and regression problems	Analyzing (K4)
CO2:	create and validate a generative model-based algorithm for classification and regression problems	Analyzing (K4)
CO3:	design, develop and validate ANN for a real time application using BPN	Analyzing (K4)
CO4:	develop a CNN model for image analysis	Evaluating (K5)
CO5:	analyze various error metrics used in supervised learning	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	3
CO2	2	1	3
CO3	2	1	3
CO4	3	1	3
CO5	3	1	3

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

18MWE12 CYBER PHYSICAL SYSTEMS

(Common to Information Technology(ICW) & Mechatronics branches)

L	T	P	Credit
3	0	0	3

Preamble	This subject strives to identify and introduce the durable intellectual ideas of embedded systems as a technology and as a subject of study. The emphasis is on modeling, design, and analysis of cyber-physical systems, which integrate computing, networking, and physical processes
Prerequisites	Nil

UNIT – I **9**

Cyber Physical Systems: Introduction- Applications -Modeling dynamic behaviors –continue dynamics – Newtonian mechanics – actor models – properties of systems – feedback control-Discrete dynamics: discrete systems – the notion of state – finite-state machines – extended state machines – non determinism – behaviors and traces

UNIT – II **9**

Hybrid Systems: Modal models – classes of hybrid systems-Composition of state machines: concurrent composition – hierarchical state machines-Concurrent models of computation: structure of models – synchronous-reactive models – dataflow models of computation – timed models of computation

UNIT – III **9**

Design of Embedded Systems: Embedded processors: types of processors – parallelism-Memory architectures: memory technologies – memory hierarchy – memory models-Input and output: i/o hardware – sequential software in a concurrent world – the analog digital interface-Multi Tasking: Imperative programs – threads – processes and message processing- Scheduling : basics of scheduling – rate monotonic scheduling – earliest deadline first – scheduling and mutual exclusion – multiprocessor scheduling

UNIT – IV **9**

Analysis and Verification: Invariants and temporal logic: invariants – linear temporal logic-Equivalence and refinement: models as specifications – type equivalence and refinement – language equivalence and containment – simulation – bisimulation- Reachability analysis and model checking: open and closed systems – reach ability analysis – abstraction in model checking – model checking liveness properties

UNIT – V **9**

Quantitative Analysis: Problems of internet – programs as graphs – factors determining execution time – basics of execution time analysis – other quantitative analysis problems- Sets and functions: sets – relations and functions – sequences- Complexity and computability: effectiveness and complexity of algorithms – problems, algorithms and programs – turing machines and un decidability – intractability: P and NP

Total: 45

REFERENCES:

1. Lee E.A. and SeshiaS.A., “Introduction to Embedded Systems - A Cyber-Physical Systems Approach” , 2nd Edition , UC Berkeley, 2017.
2. Peter Marwedel, “Embedded system design – Embedded systems foundations of cyber- physical systems and the Internet of things”, 3rd Edition , Springer Publisher, 2018.
3. http://LeeSeshia.org

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify the applications and the methods for modeling dynamic behaviors of cyber physical systems	Understanding (K2)
CO2:	explain the concurrent models of computation for the hybrid systems	Understanding (K2)
CO3:	design an embedded system for cyber physical systems	Applying (K3)
CO4:	analyze the invariants and temporal logic models for open and closed systems	Analyzing (K4)
CO5:	analyze the effectiveness and complexity of algorithms	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	1
CO2	2	1	2	2	1
CO3	3	2	3	3	2
CO4	3	2	3	3	2
CO5	2	2	2	2	2

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

18MME10 MECHATRONICS SYSTEM DESIGN AND CONTROL

L	T	P	Credit
3	0	2	4

Preamble: To impart knowledge in Mechatronics system design for real time applications.

Prerequisites: Advanced Mathematics for Mechatronics, Control System Engineering

UNIT – I **9**

Introduction: Mechatronics systems - key elements - mechatronics design process - types of design - traditional and mechatronics design - integrated product design - advanced approaches in mechatronics - industrial design and ergonomics - safety.

UNIT – II **9**

Concepts of System and Modeling: Concept of systems - modeling of systems - model representations: block diagram, transfer function, state space model - system identification techniques – linearization of nonlinear models – model development for physical systems in a software environment.

UNIT – III **9**

Simulation of Mechatronics Systems: Simulation: Basics, types, Hardware-in-the-loop simulations – time response parameters – frequency response parameters- simulation of physical systems in software environment.

UNIT – IV **9**

Controller Design: Basic elements of control system – open loop and closed loop systems – characteristics of on-off, P, PI, PD and PID controllers –implementation issues of PID controller – modified PID controller – tuning of PID controllers.

UNIT – V **9**

Case Studies: Building Mechatronics systems for measurement and control applications in a software environment.

List of Experiments:

1. Introduction to modeling and simulation of mechatronics system using MATLAB
2. Time response analysis of PID controller for level process
3. Time response analysis of PID controller for temperature process
4. Time response analysis of PID controller for flow process
5. Time response analysis of PID controller for pressure process loop
6. Speed variation analysis of electromechanical gear trains
7. Closed loop control of servo control system
8. Closed loop control of inverted pendulum system
9. Closed loop control of ball and beam system
10. Closed loop control of magnetic levitation system

Lecture: 45, Practical: 15, Total: 60

REFERENCES:

1. Shetty Devdas and Kolk Richard A., "Mechatronics System Design", 2nd Edition, CT Cengage Learning, Stamford, 2011.
2. Bolton W., "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", 6th Edition, Pearson Education Ltd., New York, 2015.
3. Robert H. Bishop, "The mechatronics handbook - Fundamentals and modeling", 2nd Edition, CRC Press, London, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify the components of mechatronics system design	Understanding (K2)
CO2:	explain the concepts of system modeling	Understanding (K2)
CO3:	simulate the physical systems using software environment	Applying (K3)
CO4:	design PID controllers for mechatronics system	Evaluating (K5)
CO5:	build a mechatronics system and simulate using software	Creating (K6)
CO6:	design controller for real time processes	Creating (K6), Precision (S3)
CO7:	analyze the time domain specification of processes	Analyzing (K4), Precision (S3)
CO8:	analyze the characteristics of stable and unstable systems	Analyzing (K4), Precision (S3)

Mapping of COs with POs

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

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

18MME11 MACHINE VISION SYSTEM

L	T	P	Credit
3	0	2	4

Preamble: To impart knowledge on image processing based automatic inspection and analysis for applications such as automatic inspection, process control and robot guidance in industry.

Prerequisites: Sensors and Instrumentation

UNIT – I **9**

Fundamental Concepts: Processing of information in human visual system - Adaptation to different light level. Introduction to Machine Vision System: components and specification, advantages and disadvantages - Working principle of MVS – Task and benefit – Performance requirement.

UNIT – II **9**

Design of Machine Vision System: Camera type - Field view - Resolution - Spatial resolution - Measurement of accuracy – Calculation of resolution - Choice of camera - Frame grabber and hardware platform - Pixel rate - Lens design – Focal length – Choice of illumination.

UNIT – III **9**

Lighting System: Demands on Machine Vision Lighting - Light and light perception - Light characteristics - Light sources: monochromatic light, white light, UV, IR LED and laser – Polarized lighting - Basic rules and laws of light distribution - Light filter - Directional properties of the light - Types of illuminators - Properties of illuminated field.

UNIT – IV **9**

Camera Computer Interface and Image Processing: Analog camera buses – Parallel digital camera buses - Standard pc buses – Computer buses – Driver software. introduction to digital images – Image analysis: basic, scalar, arithmetic- Image enhancement: thresholding, histogram, line profile, intensity measurement – Image processing – Geometric transformation – Image segmentation - Feature extraction – Morphology – Edge detection – Fitting - Template matching.

UNIT – V **9**

Software and Applications: Diameter inspection of rivets – Tubing inspection – Glue check under UV light – Completeness check of automotive control component – Multiple position and completeness check of small hybrid circuit – Pin type verification.

List of Experiments:

1. Study on vision and motion tools in LabVIEW
2. Study on smart camera interface using vision development module
3. Study on Image processing and Image calibration using LabVIEW
4. Develop graphical program to inspect defects in industrial components
5. Develop graphical program to identify objects using Color / Pattern matching
6. Develop graphical program to inspect product label
7. Develop graphical program to inspect missing part in the product
8. Check the dimension of the spark plug and count the number of edges in it
9. Count the number of defect tablets in the given blister
10. Identify and count the number of circular edges in the given product

Lecture: 45, Practical:15, Total: 60

REFERENCES:

1.	Alexander Hornberg, “Handbook of machine vision”, Wiley-VCH, 2007.
2.	Davies E.K., “Machine Vision: Theory, Algorithms, Practicalities”, 3rd Edition, Elsevier, 2005.
3.	Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, 4th Edition, Nelson Education Ltd., 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	compare the processing of information in human visual system with machine vision system	Understanding (K2)
CO2:	identify the components involved in designing machine vision system	Applying (K3)
CO3:	choose the appropriate lighting system and camera computer interface for real time applications	Applying (K3)
CO4:	summarize the different image processing techniques available for vision system	Understanding (K2)
CO5:	develop solution for real time applications using machine vision system	Analyzing (K4)
CO6:	interface camera and process the image using LabView	Analyzing (K4), Precision (S3)
CO7:	inspect the defects and identify the object using LabView	Creating (K6), Precision (S3)
CO8:	check the dimensions and count the objects using LabView	Creating (K6), Precision (S3)

Mapping of COs with POs

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

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

18MME12 AUTONOMOUS MOBILE ROBOTICS

(Common to Mechatronics & CAD CAM branches)

L	T	P	Credit
3	0	2	4

Preamble: The course on Autonomous Mobile Robots provides the fundamentals of mobile robotics and the basic principles of locomotion, kinematics, sensing, perception and cognition which are the key elements to develop the autonomous mobile robots.

Prerequisites: Robotics Engineering

UNIT – I **9**

Mobile Robot Kinematics: Introduction **-** Kinematic models and constraints – Manoeuvrability – Workspace – Motion control

UNIT – II **9**

Locomotion: Introduction – Key issues for locomotion – Legged mobile robots – Wheeled mobile robots – Aerial mobile robots

UNIT – III **9**

Perception: 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 **9**

Localization: Introduction – Challenges of localization – Belief representation – Map representation – Probabilistic Map-Based localization – Autonomous map building.

UNIT – V **9**

Planning and Navigation: 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

18MME13 MEMS DESIGN

(Common to Mechatronics, CADCAM, Engineering Design, VLSI Design, Applied Electronics, Power Electronics and Drives & Control and Instrumentation Engineering branches)

L	T	P	Credit
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.

Prerequisites: Sensors and Instrumentation and Bridge course mechanical

UNIT – I **9**

Materials for MEMS and Scaling Laws: 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 **9**

Micro Sensors, Micro Actuators: 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 **9**

Mechanics for Microsystem Design: 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 **9**

Fabrication Process and Micromachining: Photolithography - Ion implantation - Diffusion – Oxidation – CVD - Physical vapor deposition - Deposition by epitaxy - Etching process- Bulk Micro manufacturing - Surface micro machining – LIGA –SLIGA.

UNIT – V **9**

Micro System Design, Packaging and Applications: 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

18MME14 MACHINE TOOL CONTROL AND CONDITION MONITORING

(Common to Mechatronics & CADCAM branches)

L	T	P	Credit
3	0	0	3

Preamble: To impart the knowledge in machine tool control and condition monitoring in a mechatronics perspective.

Prerequisites: Nil

UNIT – I **9**

Overview of Automatic Control in Machine Tools: 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 **9**

Adaptive Control and PLC: Adaptive control: ACC, ACO, Real time parameter estimation, Applications of adaptive control for turning, milling, grinding and EDM. Programmable logic controller: Functions, Applications in machine tools.

UNIT – III **9**

Introduction to Condition Monitoring: Condition Monitoring: 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 **9**

Vibration, Acoustic Emission and Sound Monitoring: Primary and 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 **9**

Condition Monitoring through other techniques: Visual and temperature monitoring - Leakage monitoring - Lubricant monitoring - condition monitoring of Lube oil and Hydraulic systems - Thickness monitoring - Image processing techniques in condition monitoring.

Total: 45

REFERENCES:

1. Sushil Kumar Srivastava, "Industrial Maintenance Management" S. Chand & Company Ltd., New Delhi, 2016.
2. Mishra R.C., Pathak K., "Maintenance Engineering and Management", Prentice Hall of India Pvt. Ltd., 2016.
3. Robert Bond Randall, "Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications", John Wiley & Sons Ltd., 2014.

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	Analyzing (K4)
CO5:	select appropriate condition monitoring technique for machine tool control applications	Analyzing (K4)

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

18MME15 BIO MECHATRONICS

L	T	P	Credit
3	0	0	3

Preamble: To impart knowledge in application of mechanics in medicine, properties and kinematics of bone and muscles

Prerequisites: Advanced Mathematics for Mechatronics, Sensors and Instrumentation

UNIT – I **9**

Introduction: Introduction to bio-mechanics: relation between mechanics and medicine, Newton's laws, stress, strain, shear rate, viscosity, visco elasticity, non-Newtonian viscosity and soft tissue mechanics. Mechanical properties of soft biological tissues - Bio fluid mechanics - Introduction to Biomechatronic Systems.

UNIT – II **9**

Mechanics in Skeletal and Muscular System: Bones, types, mechanical properties and functions - Axial and Appendicular Skeleton. Joints: Definition, Types and functions. Kinetics and Kinematics relationship of skeletal and muscular system.

UNIT – III **9**

Control Mechanism of Biological Systems: Skeletal muscles servo mechanism - Cardio vascular control mechanism - respiratory control mechanism – interfacing techniques with natural servo mechanism

UNIT – IV **9**

Prosthetic and Orthotic Devices: Analysis of force in orthopedic implants: Hand and arm replacement - Different types of models for externally powered limb prosthetics: Lower limb, Upper limb orthotics and material for prosthetic and orthotic devices. Functional Electrical Stimulation - Sensory Assist Devices.

UNIT – V **9**

Simulation and Modelling of Bio mechatronics: Physics based modelling and simulation of biological structures - Variables of interest - Geometry - Introduction to model the skeletal system using open source software - Human leg prosthesis - Normal gait vs prosthesis leg analysis - Upper Extremity Kinematic Model

Total: 45

REFERENCES:

1. Ethier C.R., and Simmons C.A., "Biomechanics from Cells to Organisms", Cambridge University Press, 2007.
2. Dawson D. and Right, "Introduction to Bio-mechanics of Joints and Joint Replacement", Wiley Publications Ltd., 1991.
3. Jacob Kline, "Handbook of Bio Medical Engineering", Academic Press, 1988.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify the components of biomechatronic systems	Understanding (K2)
CO2:	interpret the concept of mechanics in skeletal and muscular system	Understanding (K2)
CO3:	develop control mechanism for biological systems	Applying (K3)
CO4:	identify the prosthetic and orthotic devices	Analyzing (K4)
CO5:	simulate and model bio mechatronics systems	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1	1	2
CO2	1	1	2
CO3	1	1	2
CO4	1	1	2
CO5	3	3	3

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

18MME16 ADDITIVE MANUFACTURING

(Common to Mechatronics & CADCAM branches)

L	T	P	Credit
3	0	0	3

Preamble: This course provides scientific as well as technological aspects of various additive, subtractive and formative rapid manufacturing processes. Variety of applications also will be covered ranging from rapid prototyping, rapid manufacturing to mass customization.

Prerequisites: Nil

UNIT – I **9**

Introduction to RP systems: 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- Creation of STL file - History of RP systems - Classification of RP systems - Benefits of RPT.

UNIT – II **9**

Liquid based RP systems: 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 Object Ultraviolet Laser Printer (SOUP): Principle, Process parameters, Process details, Machine details, Applications.

UNIT – III **9**

Solid based RP systems: 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 **9**

Powder based RP systems: 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, Concept Modelers.

UNIT – V **9**

Rapid Tooling and Applications of RP: Direct Rapid Tooling: Direct AIM, Quick cast process, Copper polyamide, Rapid Tool, DMLS, ProMetal, Sand casting tooling. Indirect Rapid Tooling: Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, soft tooling vs hard tooling. Applications of RP in product design: automotive industry, medical field – Conversion of CT/MRI scan data - Customized implant - Case studies -reverse engineering - Surface Generation from points on cloud - Growth of RP industry.

Total: 45

REFERENCES:

1. Chua C. K., Leong K.F. and Lim C.S., "Rapid Prototyping: Principles and Applications", World Scientific, New Jersey, 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, 2016.

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:	relate the various tooling systems and reverse engineering concepts for rapid manufacturing 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	3

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

18MME17 AUTOMOTIVE ELECTRONICS AND CONTROL

L	T	P	Credit
3	0	0	3

Preamble: To impart the fundamental knowledge of engine and the usage of sensors, actuators, electronic components to integrate electronics with automobile.

Prerequisites: Basics of Electronics

UNIT – I **9**

Automotive Electronics Fundamentals and Emissions: Evolution of electronics in automobile - Ignition system- Fuel system- Cooling system - Exhaust system- MPFI, CRDI, Euro Norms, Equivalent Bharat Stage Norms.

UNIT – II **9**

Sensors and Actuators: Introduction - Types of sensors: oxygen sensor, crank shaft position sensor, temperature sensor, engine oil pressure sensor, fuel metering, vehicle speed sensor and detonation sensor – Airbag sensors, feedback carburetor systems - Solenoids - Stepper motors- Relays.

UNIT – III **9**

Engine Management System: Electronic fuel control - Electronic ignition system - Combined ignition and fuel management - Advanced engine management technology – Application of CAN network in engine ECU – BOSCH Monojetronic and L jetronic system - Diagnostics systems in modern automobiles.

UNIT – IV **9**

Chassis Control and Safety: Anti-lock brakes - Traction control – Electronic Power Steering- Body Electronics-Automatic transmission - Cruise control - Airbags system – Application of Control elements and control methodology in automotive system.

UNIT – V **9**

Automotive Electricals: Vehicle electrical systems and circuits – Batteries – Charging systems – Starting systems – Dash board instruments – Horn –– Electric and hybrid vehicles – OBD diagnostics, BOSCH driver assistance systems.

Total: 45

REFERENCES:

1. Ribbens William B., "Understanding Automotive Electronics", 6th Edition, Newnes Publishing, 2003.
2. Denton Tom, "Automobile Electrical and Electronics Systems", 5th Edition, Routledge Publishers, 2017.
3. Kohli P.L., "Automotive Electrical Equipment", 1st Edition, McGraw-Hill, New York, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the fundamentals of automobile electronics and emissions	Understanding (K2)
CO2:	interpret automotive sensors and actuators used in automotive system	Applying (K3)
CO3:	identify the elements of engine management system	Understanding (K2)
CO4:	analyze the importance of safety system used in automotive cars	Analyzing (K4)
CO5:	discover the need of electrical accessories in automotive systems	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	1
CO2	2	1	1
CO3	3	1	3
CO4	2	1	2
CO5	1	1	1

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