PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018
(AUTONOMOUS)
B.E. MECHATRONICS
REGULATIONS - 2019
CURRICULUM
(For the students admitted during academic year 2020-2021 onwards)

SEMESTER V

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	HS	BA20151	Entrepreneurship Development	3	0	0	3
2	PC	MT20501	Power Electronics	3	0	0	3
3	PC	MT20502	Design of Machine Elements	3	1	0	4
4	PC	MT20503	Sensors and Instrumentation	3	0	0	3
5	PC	MT20504	Control Systems	3	0	0	3
6	PE	MT2015*	Professional Elective - I *	3	0	0	3
Practical							
7	PC	MT20505	Power Electronics Laboratory	0	0	4	2
8	PC	MT20506	Sensors and Instrumentation Laboratory	0	0	2	1
9	EE	EN20501	Career Development Laboratory I	0	0	2	1
			Total	**18**	**1**	**8**	**23**

SEMESTER VI

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	MT20601	CNC Technology	3	0	0	3
2	PC	MT20602	Mechatronics System Design	3	0	0	3
3	PC	MT20603	PLC and Automation	3	0	0	3
4	PC	MT20604	Fluid Power Automation	3	0	0	3
5	PE	*******	Professional Elective - II *	3	0	0	3
6	OE	MT2090*	Open Elective - I*	3	0	0	3
Practical							
7	PC	MT20605	PLC and Automation Laboratory	0	0	2	1
8	PC	MT20606	Fluid Power System Laboratory	0	0	2	1
9	EE	EN20601	Career Development Laboratory II	0	0	2	1
			Total	**18**	**0**	**6**	**21**

PROFESSIONAL ELECTIVE COURSES (PE)

PROFESSIONAL ELECTIVE - I

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	MT20151	Digital Signal Processing	3	0	0	3
2	PE	MT20152	Advanced Manufacturing Processes	3	0	0	3
3	PE	MT20153	Diagnostic Techniques	3	0	0	3
4	PE	MT20154	Product Design and Costing	3	0	0	3

PROFESSIONAL ELECTIVE - II

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	IT20256	Computer Communication Networks	3	0	0	3
2	PE	MT20251	Engineering Economics and Cost Analysis	3	0	0	3
3	PE	MT20252	Design of Jigs, Fixtures and Press Tools	3	0	0	3
4	PE	MT20253	Additive Manufacturing	3	0	0	3

OPEN ELECTIVE COURSES (OE)

OPEN ELECTIVE – I

S. No	Category	Course Code	Course Title	L	T	P	C
1	OE	MT20901	Non-Destructive Testing	3	0	0	3
2	OE	MT20902	Mobile and Autonomous Robots	3	0	0	3

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BA20151 **ENTREPRENEURSHIP DEVELOPMENT** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand the Management principles.
- build the entrepreneurial competencies & analyse the support rendered by government and other agencies in entrepreneurship development.
- understand the business opportunities & to prepare a Feasibility Report.
- propose a business plan.
- appraise & comprehend the various factors to be considered for launching a small business.

UNIT I BASICS OF MANAGEMENT 9

Management: Meaning, Definition, Nature and Importance; Roles of management - Functions of Management - Levels of Management - Functional areas of Management: Marketing, Finance, Production, HRM, IT, R & D.

The Evolution & Development of Management Thought : Classical, Neo -classical, System and Contingency Approaches - An Overview.

UNIT II ENTREPRENEURIAL COMPETENCE & ENVIRONMENT 9

Entrepreneurial Competence: Entrepreneurship – Definition, Role and expectations – Entrepreneurial styles and types – Characteristics of the Entrepreneur - Entrepreneurial Competencies – Functions of an Entrepreneur.

Entrepreneurial Environment: Role of Socio-Cultural, Economic and Political Environment – Institutional Support for small entrepreneurs, Assistance Programme for Small Scale Units – Institutional Framework, Central and State Government Industrial Policies and Regulations.

UNIT III ENTREPRENEURIAL DEVELOPMENT 9

Ownership Structures – Proprietorship, Partnership, Company, Co-operative, Franchise.

Identification of Business Opportunity – Preparation of Feasibility Report – Financial and Technical Evaluation – Project Formulation – Common Errors in Project Formulation – Specimen Project Report.

Entrepreneurial Development Programs — Role of SSI Sector in the Economy – IAS Units – Failure, Causes and Preventive Measures – Turnaround Strategies.

UNIT IV BUSINESS PLAN PREPARATION, FINANCING VENTURES 9

Business Plan: Business opportunities-SWOT, Business plan process, Feasibility Study, Functional plan-Marketing plan, Operational plan, Organizational plan, financial plan, Evaluation Criteria.

Financing ventures: sources of raising capital, seed funding, venture capital funding, funding opportunities for startups in India.

UNIT V WOMEN ENTREPRENEURSHIP AND ENTREPRENEURSHIP IN VARIOUS SECTORS 9

Women Entrepreneurship: Growth of women Entrepreneurship – Problems faced by Women Entrepreneurs – Development of women Entrepreneurship.

Entrepreneurship in Informal Sector: Rural Entrepreneurship – Entrepreneurship in Sectors like Agriculture, Tourism, Health care, Transport and allied services.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- implement the necessary managerial skills to become an entrepreneur.
- take up self-employment having been exposed to entrepreneurial environment.
- select a best business idea by using appropriate methods to assess its viability.
- formulate a business plan & deploy the resources for sustainable growth.
- analyse channels and means of launching a small business in any sector.

TEXT BOOKS

1. Khanka S.S, "Entrepreneurial Development", S. Chand & Company Limited, New Delhi, 2016.
2. Saravanavel. P, "Entrepreneurial Development", Ess Pee Kay Publishing House, Chennai, 2013.

REFERENCES

1. Donald L. Sexton & Raymond W.Smilor, "The Art and Science of Entrepreneurship", Ballinger Publishing Company, 2008.
2. Clifford M.Baumback & Joseph R.Mancuso, "Entrepreneurship and Venture Management", Prentice Hall, 1975.
3. Gifford Pinchot, "Intrapreneuring" Harper & Row Publishers, New York, 2005.
4. Mathew Manimala, "Entrepreneurship Theory at the Crossroads", Paradigms & Praxis, Biztrantra, 2nd Edition, 2015.
5. Prasanna Chandra, "Projects – Planning, Analysis, Selection, Implementation and Reviews", Tata McGraw-Hill, 2013.
6. P.C.Jain, "Handbook for New Entrepreneurs", EDII, Oxford University Press, New Delhi, 2012.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	3	1	-	2	2	2	-	2	3	2	3
CO2	-	2	2	-	2	1	-	-	-	-	1	1	1	3
CO3	-	1	1	-	1	1	1	-	1	1	1	3	-	3
CO4	1	1	-	-	-	-	1	-	3	1	1	1	1	2
CO5	1	1	1	-	1	1	2	-	2	1	1	1	1	1

MT20501 **POWER ELECTRONICS** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- impart knowledge on different types of power semi-conductor devices and their switching characteristics.
- know the controlling techniques of switching devices and protection of power semiconductor devices.
- understand the operation of Phase controlled converter and various chopper conversion techniques.
- study the mode of inverters and different modulation techniques.
- learn the types of AC voltage controllers and basics of matrix converters.

UNIT I POWER SEMICONDUCTOR DEVICES **9**

Study of switching devices and its static characteristics - Power Diode, SCR, GTO, RCT, LASCR, TRIAC, BJT, Power MOSFET, IGBT.

UNIT II GATE DRIVE AND PROTECTION CIRCUITS **9**

Gate triggering circuits - Firing circuit for the SCR, R, RC, UJT; Drive circuits for BJT, gate drive circuits for MOSFET and IGBT; Isolation of gate and base drives: Pulse transformer, optocouplers; Protection circuits - Snubber circuits, di/dt protection with the help of inductor, over current protection; Cooling of semiconductor devices, types of cooling.

UNIT III THYRISTOR RECTIFIERS AND CHOPPER **9**

Phase controlled converter- 2-pulse, 3-pulse and 6-pulse converters; Effect of source inductance; Chopper-step-down and step-up chopper, switched mode regulators, buck, boost, buck-boost converter; Introduction to resonant converters.

UNIT IV INVERTERS AND PWM TRCHNIQUES **9**

Single phase and three phase voltage source inverters (both 1200 mode and 1800 mode), PWM techniques: Sinusoidal PWM, modified sinusoidal PWM, multi PWM; Introduction to space vector modulation; Current source inverter, Applications - induction heating, UPS.

UNIT V AC TO AC CONVERTERS AND APPLICATIONS **9**

Single phase AC Voltage Regulator and Three phase AC Voltage Regulator - Power Factor Control - multistage sequence control - Sequence control of AC regulators, Single phase cyclo converters and Three phase cycloconverters - Introduction to matrix converters - welding.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify and select the switching devices for different power converter applications.
- apply the different controlling techniques and protection schemes based on the load.
- design a suitable DC power supply for given load specification from AC and DC supply.
- describe and analyze the single and three phase inverters.
- explain an AC voltage controller electromagnetic compatibility of power converters.

TEXT BOOKS

1. M.H.Rashid, Power Electronics: Circuits, Devices Applications, Pearson, 2016.
2. M.D. Singh and Khanchandani K.B., Power Electronics, Tata Mc.Graw Hill., 2016

REFERENCES

1. L.Umanand, Power Electronics Essentials and Applications, Wiley India Pvt Ltd, Reprint, 2015.
2. G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, Thyristorised Power Controllers, NewAge, International Publishers, 2017.
3. Ned Mohan,Tore M. Undeland and William P.Robins, Power Electronics – Converters, Applications and Design Third Edition, John Wiley and Sons, 2018.
4. R.S. Ananda Murthy and V. Nattarasu, Power Electronics: A Simplified Approach, Pearson /Sanguine Technical Publishers, 2017.

CO PO MAPPING:

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COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	1	-	2	1	-	1	-	1	1	1	3	3
CO2	3	2	1	-	2	1	-	1	-	-	2	1	3	3
CO3	3	2	1	-	2	1	-	1	-	-	2	1	3	3
CO4	3	1	1	-	2	1	-	1	-	1	2	1	3	3
CO5	3	1	1	-	2	1	-	1	-	-	2	1	3	3

MT20502 DESIGN OF MACHINE ELEMENTS 3 1 0 4

(Use of PSG Design Data Book is permitted)

COURSE OBJECTIVES

To enable students to

- understand the various steps involved in the design process.
- understand the principles involved in evaluating the shape and dimensions of a component and to satisfy functional and strength requirements.
- know the standard practices and standard data.
- know the types of gears and principles of gear tooth action and mechanical drives.
- understand the knowledge in selection of bearings and springs for different applications.

UNIT I DESIGN PROCESS AND DESIGN FOR STATIC LOAD **12**

Machine Design - Design Process, Factors influencing design, Calculation of stresses for various load combinations; Theories of failure; Factor of safety; Design of curved beams - Crane hook and 'C' frame; Design of levers.

UNIT II DESIGN OF SHAFTS, KEYS AND COUPLINGS **12**

Design of solid and hollow shafts based on strength, rigidity and critical speed; Key - Types - Design of Square and Flat key; Couplings - Types - Design of Muff coupling, Clamp coupling, Rigid flange coupling and Bushed-pin flexible coupling, Applications.

UNIT III DESIGN OF JOINTS **12**

Threaded fasteners - Bolted joints including eccentric loading; Knuckle joints; Cotter joints; Welded joints – Welding symbols, Stresses in butt and fillet welds, Design of Welded Joints for static loads, Axially loaded unsymmetrical welded joints, Eccentric load in the plane of welds, Theory of bonded joints.

UNIT IV GEARS AND MECHANICAL DRIVES **12**

Classification, law of gearing, forms of tooth, interference, under cutting, minimum number of teeth on gear and pinion to avoid interference; Contact ratio; Drives classification - Types of belts drives, velocity ratio, law of belting, length of the open and cross belts, power transmitted by a belt, tension ratio, centrifugal effect on belts, initial tension in belts.

UNIT V DESIGN OF SPRINGS AND BEARINGS **12**

Design of helical, multi leaf and torsional springs under constant loads and varying loads, End conditions and length of springs; Stresses in Helical springs of circular wire. Wahl stress factor; Sliding contact and rolling contact bearings, Hydrodynamic journal bearings, Somerfield Number, Raimondi and Boyd graphs, Selection of Rolling Contact bearings

TOTAL PERIODS 60

COURSE OUTCOMES

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

- acquire knowledge about design process and the factors influencing it and design the simple components for static loading.
- design the circular shafts based on strength and rigidity, keys and couplings for power transmitting elements.
- analyze the forces acting on bolts in eccentric loading, welded joints and design the elements.
- design and optimize the selection of gears and drives for automotive components and machine elements.
- formulate the design procedure for springs and understand the rolling contact bearings for static and cyclic loads, select the lubricants and bearing dimensions for hydrodynamic lubrication.

TEXT BOOKS

1. Bhandari V B, "Design of Machine Elements", 5th Edition, Tata McGraw-Hill Book Co, 2020.
2. Joseph Shigley, Richard G. Budynas, J. Keith Nisbett and Kiatfa Tangchaichit "Mechanical Engineering Design", 11th Edition, Tata McGraw-Hill, 2020.

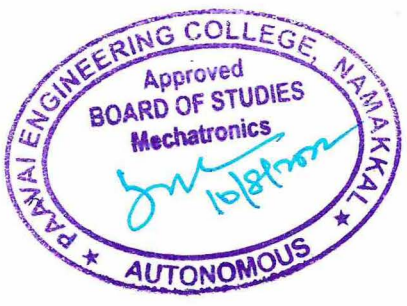
REFERENCES

1. Sundararajamoorthy T. V. Shanmugam. N, "Machine Design", Anuradha Publications, Chennai, 2018.
2. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Component Design", 7th Edition, John Wiley & Sons Inc, 2020.
3. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", McGraw Hill Education, 2017.
4. Ansel C. Ugural, "Mechanical Design of Machine Components", Taylor & Francis, 2018.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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



MT20503 **SENSORS AND INSTRUMENTATION** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- gain knowledge in units, standards, error analysis and characteristics of measurement systems.
- know about the different devices available in mechanical measurement.
- understand the basic laws used in the operation of electrical instruments and measurement techniques.
- learn a signal conditioning circuit and data acquisition system.
- understand the construction, working principles and characteristics of bio medical sensors.

UNIT I SCIENCE OF MEASUREMENT **9**

Units and Standards; Calibration techniques; Errors in Measurements; Generalized Measurement System; Static and dynamic characteristics of transducers; Generalized Performance of Zero Order and First Order Systems; Response of transducers to different Time varying inputs; Classification of transducers.

UNIT II MECHANICAL MEASUREMENTS **9**

Temperature measurement - Filled thermometer, Bimetallic thermometer; Pressure measurement - Bourdon gauge, Bellows, Diaphragm; Vacuum measurement - McLeod gauge, Thermal conductivity gauge, Ionization gauge; Flow Measurement - Turbine flow meter, Hot wire Anemometer, Float level sensor.

UNIT III ELECTRICAL MEASUREMENTS **9**

Potentiometer; RTD; Thermistor; Thermocouple; Strain gauges; LVDT; RVDT; Capacitive transducers; Piezo electric transducer; Pyrometers; Load cell; Hall effect transducers; Photoelectric transducers; Fiber optic transducers; Hygrometer.

UNIT IV SIGNAL CONDITIONING AND DATA ACQUISITION **9**

Amplification; Filtering; Sample and Hold circuit; Analog to Digital converter; Digital to Analog converter; Data Acquisition; Data Logging; Data conversion; Digital Transmission system; Display devices - LED and LCD.

UNIT V MEASUREMENT OF BIO SIGNALS **9**

Components of the biomedical instrument system; Bioelectric potentials - Resting and action potential; Electrodes - Types of electrodes - Depth and needle electrodes, Surface electrodes; ECG; EEG; Heart and lungs machine; Kidney machine.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify the units and standards, their conversions, characteristics and error analysis of systems.
- describe the different devices available in mechanical measurements
- classify and describe resistive, inductive and capacitive transducers which are used for measuring various parameters like displacement, temperature, humidity etc.
- design a signal conditioning circuit and data acquisition system.
- use bio sensors and transducers to create simple mechatronics system.

TEXT BOOKS

1. A.K.Sawhney and P.Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2017.
2. R S Khandpur, "Handbook of Biomedical Instrumentation", 3rd edition, McGraw Hill Education, 2014.

REFERENCES

1. D. Patranabis, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2021.
2. Ernest O. Doebelin and Dhanesh N. Manik, "Measurement Systems", 7th Edition, Tata McGraw- Hill, 2019.
3. D. Patranabis, Principles of Industrial Instrumentation, 3rd Edition, McGraw Hill Education, New Delhi, 2017.
4. R. K. Rajput, "Mechanical Measurements and Instrumentation", Reprint 2013 edition, S.K. Kataria & Sons, 2013.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	-	2	2	1	-	3	2	1	-	2	3
CO2	2	1	-	-	-	3	2	1	3	2	1	-	-	-
CO3	-	3	2	1	2	-	-	3	2	-	2	2	-	1
CO4	2	3	2	-	1	2	2	1	-	3	2	1	-	2
CO5	-	2	2	1	2	-	-	3	2	-	2	2	-	1

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MT20504 CONTROL SYSTEMS 3 0 0 3

COURSE OBJECTIVES

To enable students to

- understand the methods of representation of systems and to obtain system transfer function models.
- provide knowledge on time response of systems and steady state error analysis.
- acquaint basic knowledge in obtaining the closed–loop frequency responses of systems.
- impart the concept of stability of control system and methods of stability analysis.
- learn the various approach for the state variable analysis.

UNIT I SYSTEMS REPRESENTATION 9

Basic elements in control systems - open loop and closed loop with applications - Transfer functions of mechanical, electrical and analogous systems - Block diagram reduction - signal flow graphs.

UNIT II TIME RESPONSE ANALYSIS 9

Time response - Time domain specifications - Types of test input - I and II order system response - Error coefficients - Steady state error, error constants - Generalized error series. PID control-Analytical design for PD,PI,PID control systems.

UNIT III FREQUENCY RESPONSE AND SYSTEM ANALYSIS 9

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot - Polar Plot- Nyquist plots.

UNIT IV STABILITY OF CONTROL SYSTEMS 9

Characteristics equation - Location of roots in S plane for stability - Routh Hurwitz criterion - Root locus construction - Effect of pole, zero addition - Gain margin and phase margin - Nyquist stability criterion.

UNIT V CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS 9

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- develop a mathematical model of a physical system and compute the transfer function using block diagram reduction technique and Signal flow graph..
- analyze the transient response of control systems in using time domain.
- evaluate and analyze control systems using frequency domain methods.
- check the stability of systems and the effect of pole zero addition.
- design various transfer functions of digital control system using state variable models.

TEXT BOOKS

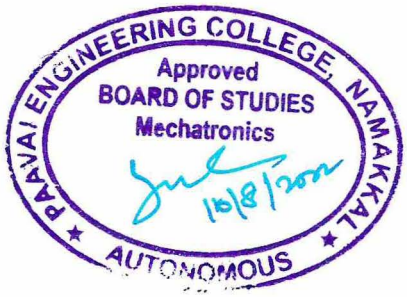
1. I.J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International Publishers, 2017.
2. A.Nagoorkani, "Control Systems", RBA Publications, 2018.

REFERENCES

1. B.C. Kuo, "Automatic Control Systems", Prentice Hall of India Ltd., 2017.
2. M. Gopal, "Control Systems, Principles & Design", Tata McGraw Hill, 2017.
3. K. Ogata, "Modern Control Engineering", Pearson Education, 2015.
4. S.K.Bhattacharya, "Control System Engineering", Pearson, 2018.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	2	2	-	-	-	-	-	-	-	-	-	3
CO2	1	2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	1	3	3	-	-	-	-	-	-	-	-	-	-	3
CO4	1	2	3	1	-	-	-	-	-	-	-	-	-	2
CO5	1	2	1	2	-	-	-	-	-	-	-	-	-	3



MT20505 POWER ELECTRONICS LABORATORY 0 0 4 2

COURSE OBJECTIVES

To enable students to

- study the characteristics of switching devices.
- learn the applications of rectifiers.
- know performance of inverters and choppers.
- train with the design concepts of AC voltage controllers, and its's controlling techniques.

LIST OF EXPERIMENTS

1. Characteristics of SCR and TRIAC.
2. Characteristics of MOSFET and IGBT.
3. Gate Pulse Generation using R, RC and UJT.
4. Voltage commutation.
5. Current commutation.
6. AC to DC half-controlled converter.
7. AC to DC fully controlled converter.
8. Step down and step up MOSFET based choppers.
9. IGBT based single phase PWM inverter.
10. IGBT based three phase PWM inverter.
11. AC Voltage controller.
12. Cycloconverter.

TOTAL PERIODS 60

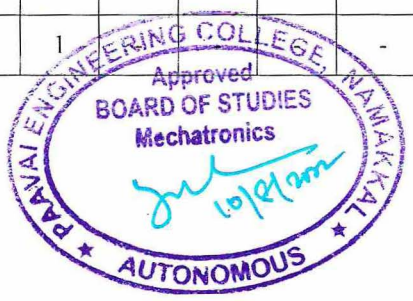
COURSE OUTCOMES

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

- compare and contrast the performance and applications of various power semi converter devices.
- design the various phase-controlled rectifiers with different loads.
- analyze the chopper circuit using MOSFET, IGBT and PWM inverters.
- evaluate the performance of AC voltage converters.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	1	-	1	-	-	2	2	3	3
CO2	2	2	1	2	-	2	1	-	-	1	2	2	3	3
CO3	2	2	1	2	-	2	-	-	1	-	2	2	3	3
CO4	2	2	1	2	-	1	-	-	-	-	2	2	3	3



MT20506 **SENSORS AND INSTRUMENTATION LABORATORY** **0 0 2 1**

COURSE OBJECTIVES

To enable students to

- understand the concept of temperature measurement devices.
- know the working of displacement measurement devices.
- understand the concept of strain and torque measurement devices.
- learn skills needed in PC based data acquisition system.

LIST OF EXPERIMENTS

1. Measurement of temperature using thermocouple.
2. Measurement of temperature using thermistor.
3. Measurement of temperature using RTD.
4. Measurement of linear and rotary displacement using potentiometer.
5. Measurement of displacement using LVDT.
6. Strain measurement using strain gauge.
7. Torque measurement using torque sensor.
8. Speed and Position control of D.C servo motor.
9. Digital comparator.
10. Voltage to frequency and frequency to voltage converter.
11. Study on the application of data acquisition system for industrial purposes.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- choose the sensors for the measurement of temperature.
- analyze the position control using displacement measurement devices.
- select the suitable devices for strain and torque measurements.
- utilize the data acquisition system for various industrial applications.

CO PO MAPPING:

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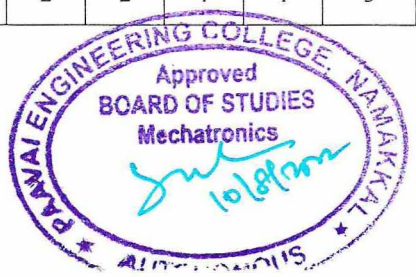
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	-	2	2	1	-	3	2	1	-	2	3
CO2	3	2	-	1	-	3	2	1	3	2	1	-	-	2
CO3	3	3	2	1	3	-	-	3	2	-	2	2	2	1
CO4	2	3	2	-	1	2	2	1	1	3	2	1	1	2



EN20501 CAREER DEVELOPMENT LABORATORY I 0 0 2 1

COURSE OBJECTIVES

To enable students to

- enhance their writing skills.
- evaluate their presentation skill to face the corporate world.
- solve the quantitative aptitude problems and improve their mental ability.
- improve the critical thinking and reasoning skills.

UNIT I WRITING SKILLS 6

Writing Skills: The Essentials of Writing – The Importance of Structure – Types of Writing – Common Mistakes in Writing.

Activities: Email Writing – Paragraph writing – Report Writing – Story Writing - Story Telling Session: 2 – JAM Session 1.

UNIT II PRESENTATION SKILLS AND GROUP DISCUSSION 6

Presentation Skills: Types of Presentation – Methods of Delivering Presentation –Ways to improve the Presentation – Presentation Aids; Group Discussion: Introduction –Types and Importance – Why GD – Types of GD- Evaluation Criteria – Do's and Don'ts of GD.

Activities: Presentation Session I, Group Discussion Session I, Role Play Session (Team): Level II – Personality Profile Session II – Company Profile Analysis Session II.

UNIT III QUANTITATIVE APTITUDE 6

Simplification – Cubes and Cube Roots – Squares and Square Roots – Boats and Streams – Trains – Profit and Loss – Pipes and Cisterns.

UNIT IV LOGICAL REASONING - I 6

Series Completion – Letter Series – Symbol Series – Number Series – Arithmetic Reasoning.

UNIT V LOGICAL REASONING - II 6

Blood Relations – Seating Arrangement - Character Puzzle.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- excel in drafting mails and speaking
- demonstrate the participative skills in group discussions.
- solve problems based on quantitative aptitude.
- enhance their logical and verbal reasoning.

TEXTBOOKS

1. Agarwal, R.S." A Modern Approach to Verbal and Non Verbal Reasoning", S.Chand & Co Ltd, New Delhi, 2015.
2. Agarwal, R.S. " Objective General English", S.Chand & Co, 2016.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill, 2015.
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications, 2016.
3. Johnson, D.W. Reaching out – Interpersonal Effectiveness and self actualization. Boston: Allyn and Bacon, 2019.
4. Infosys Campus Connect Program – students` guide for soft skills, 2015.

CO/PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (PO's)													
CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	-	-	1	-	-	-	-	2	-	2	3
CO4	2	3	3	2	1	3	3	1	-	1	2	-	2	3

SEMESTER VI

MT20601 **CNC TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- know the evolution and principle of CNC machine.
- understand the constructional features of CNC machine.
- familiarize the various drives used in CNC.
- know the part programming of CNC machine for various operations.
- understand the tooling and work holding devices for CNC machine.

UNIT I INTRODUCTION TO CNC SYSTEMS **9**

Fundamentals of NC, CNC and DNC technologies; Evolution of CNC Turning center, Evolution of CNC Milling center; Principles, specification, features, advantages and applications of CNC machines; Factors influencing the selection of CNC machines; Practical aspects of introducing CNC machines in manufacturing industry; Safety aspects of CNC machines.

UNIT II STRUCTURE AND ELEMENTS OF CNC SYSTEM **9**

Machine physical architecture - Structural details, Types of loads on CNC machine; Types of guide ways - Friction guide ways, Antifriction guide ways; Elements for rotary motion to linear motion - Screw & nut, recirculating ball screw, rack and pinion; Torque transmission elements - Gears, Timing belt; Hydraulic and pneumatic systems in a CNC system; Industry 4.0 for Machine tools.

UNIT III CNC DRIVES AND CONTROLS **9**

Spindle drive - Three phase induction motor - Construction, Characteristics, Speed control methods, VFD; Feed drive - AC Servo motor, Construction, Characteristics; Open and Closed loop position control; Feedback devices - Rotary encoder, linear scale encoder, proximity sensor, synchronous resolver; Introduction to functioning and programming of CNC Controller.

UNIT IV CNC PROGRAMMING **9**

Machine axes identification NC Programming, Part programming terminology - G and M codes; Types of interpolation; Types of Programming - Manual part programming, fixed cycle and canned cycle for turning and milling operations; Computer Assisted Part Programming (CAPP); Introduction to CNC part programming using CAD/CAM tools.

UNIT V TOOLING AND WORK HOLDING DEVICES **9**

Introduction to cutting tool materials - Carbides, Ceramics, Cubic Boron Nitride, Polycrystalline Cubic Diamond; Insert selection codes - PMK, NSH, qualified, semi qualified and preset tooling; Tooling system for Machining center and Turning center; Work holding devices for rotating and fixed work parts; Economics of CNC.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- analyse the evolution, principles, classification and applications of CNC machine.
- elaborate the basic structure, construction, working and control of CNC machine.
- expand the fundamentals of drive system and control modules of CNC.
- construct the program for various operations CNC machine.
- propose the knowledge about different tooling and working holding devices of CNC.

TEXT BOOKS

1. P. Radhakrishnan, "Computer Numerical Control Machines and Computer Aided Manufacture", 1st edition, New Age International Pvt Ltd, 2018.
2. Mahesh Dhotre and D. Rao, "CNC Machien Tool Technology with Programming and Operating", Sai Prakashan, 2018.

REFERENCES

1. Ruchi Agarwal Anup Goel and A. Jacob Moses, "Computer Aided Design & manufacturing", 1st edition, Technical Publications, 2019.
2. M. Adithan and B. S. Pabla, "CNC Machines", 3rd edition, New Age International Publishers, 2018.
3. Ahmad E Eladawi, "Computerized numerical control (CNC) technology", LAP Lambert Academic Publishing, 2020.
4. Tilak Raj, "CNC technology & programming", Reprint, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2018.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	1	-	2	-	-	-	2	-	2	3
CO2	2	-	1	-	-	-	2	1	-	-	2	-	1	2
CO3	1	-	2	-	1	-	-	1	-	-	2	-	-	1
CO4	3	-	2	-	1	-	2	2	-	-	2	-	1	2
CO5	1	-	2	-	1	-	2	1	-	-	2	-	-	2

MT20602 **MECHATRONICS SYSTEM DESIGN** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- know the basic system design process.
- understand the concept of system modelling.
- familiarize the design of mechatronics system with real time interfacing.
- understand the case studies of mechatronics system in varies fields.
- know the variety of applications of mechatronics system.

UNIT I INTRODUCTION TO MECHATRONICS SYSTEM **9**

Key elements - Mechatronics design process, Design parameters, Mechatronics and traditional design; Advanced approaches in mechatronics design; Introduction to industrial design, modelling, simulation and analysis; Ergonomics and safety.

UNIT II SYSTEM MODELLING **9**

Introduction; Model Categories - Fields of Application, Model Development, Model Verification, Model Validation, Model Simulation; Design of Mixed Systems - Electro Mechanics Design; Model Transformation Domain; Independent Description Forms - Simulator Coupling.

UNIT III REAL TIME INTERFACING **9**

Introduction – Selection of interfacing standards, Elements of data acquisition and control systems; Overview of I/O process - General purpose I/O cards and its installation; Data conversion process; Application software; Man Machine Interface.

UNIT IV CASE STUDIES ON MECHATRONICS SYSTEM **9**

Introduction; Thermal Cycle Fatigue Test of an Aluminum Plate; PH Control System; Windscreen Wiper Motion; Pick and Place Robot; Car Park Barrier; Car Engine Management; Bar Code Reader; Skip Control of a CD Player; Strain Gauge Weighing System; Rotary Optical Encoder; De Icing Temperature Control System.

UNIT V APPLICATIONS IN MECHATRONICS SYSTEM **9**

Sensors for Condition Monitoring; Mechatronics Control in Automated Manufacturing; Fuzzy Logics in Automatic washing machine; Micro Sensor – Principle, Fabrication Techniques, Applications of Micro Mechatronics Components.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify various mechatronics system design process.
- categorize the different system modeling.
- obtain knowledge about of real time interfacing.
- explain the various case studies of mechatronics system.
- outline the applications of mechatronics system design.

TEXT BOOKS

1. Devdas Shetty and Richard A. Kolk, "Mechatronics System Design", 2nd edition, Cengage, 2020.
2. Georg Pelz, "Mechatronics Systems: Modeling and Simulation with HDL's", 1st edition, John Wiley and Son Ltd, New Delhi, 2013.

REFERENCES

1. Robert H. Bishop, "The Mechatronics Hand book", 2nd Edition, CRC Press, 2018.
2. David Allan Bradley, "Mechatronics: Electronics in Products and Processes", 1st edition, Routledge, 2018.
3. Patrick O. J. Kaltjob, " Control of Mechatronic Systems: Model-Driven Design and Implementation Guidelines ", 1st edition, Wiley, 2021.
4. Farid Golnaraghi and Benjamin Kuo, " Automatic Control Systems ", 10th edition, McGraw-Hill Education, 2017.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-	-	2
CO3	2	1	3	-	-	-	-	-	-	-	-	-	-	2
CO4	2	2	1	-	-	-	-	-	-	-	-	-	-	2
CO5	3	3	2	-	-	-	-	-	-	-	-	-	-	3

MT20603 **PLC AND AUTOMATION** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand a clear view on Programmable Logic Controllers (PLC).
- know the various instructions involved in automatic control and monitoring.
- understand the PLC program for various applications.
- familiarize with the importance in maintenance of PLC.
- learn the concepts of Distributed Control System (DCS).

UNIT I PROGRAMMABLE LOGIC CONTROLLERS **9**

Introduction; Parts of PLC; Principles of operation; PLC sizes; PLC hardware components - I/O section, Analog I/O modules, Digital I/O modules; PLC programming Simple instructions; Output control devices; Latching relays; Converting simple relay diagram into PLC ladder diagram.

UNIT II INSTRUCTIONS **9**

Timer instructions - ON delay, OFF delay, Cascading timers and Retentive Timers; Counter instructions - UP counter, DOWN Counter, Cascading counters; Program control instructions; Data manipulating instructions; Math Instructions.

UNIT III APPLICATIONS OF PLC **9**

Simple materials handling applications; Automatic control of warehouse door; Automatic lubrication of supplier conveyor belt; Automatic car washing machine; Bottle Label detection; Process control application.

UNIT IV PLC MAINTENANCE **9**

PLC maintenance – Daily, Preventive, Periodic maintenance; Internal PLC faults; External PLC faults; Watch dogs; Safety - Hardware safety circuits; Troubleshooting; Electrical noise; Leaky inputs and outputs; Grounding, Voltage variation and surges.

UNIT V DISTRIBUTED CONTROL SYSTEM **9**

Introduction to DCS; Architectures; Local control unit; Process interfacing issues - Communication facilities Operator interfaces, Low level and High-level operator interfaces, Displays: Engineering interfaces - Low level and High level engineering interfaces; Factors to be considered in selecting DCS; Case studies - Sugar industry and Power plant.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify the different parts of PLC and its functions.
- analyze the use of timers and counters in PLC.
- develop the PLC program for various applications.
- apply the various maintenance techniques in the field of PLC.
- integrate the distributed control system with automation systems.

TEXT BOOKS

1. Frank D. Petruzella, "Programmable Logic Controllers", 5th edition, McGraw Hill, 2019.
2. P Michael Lukas, " Distributed Control Systems: Their Evaluation and Design", 4th edition, Van Nostrand Reinhold Co, 2016.

REFERENCES

1. Kirsten A. Morris, "Controller Design for Distributed Parameter Systems", 1st edition, Springer Nature Switzerland AG, 2021.
2. Bolton, "Programmable Logic Controllers", 6th edition, Elsevier India, 2016.
3. B. R. Mehta and Y. J. Reddy, Industrial Process Automation Systems Design and Implementation, Elsevier Inc. 2015.
4. James A. Rehg and Glenn J. Sartori, "Programmable Logic Controllers", 2nd edition, Pearson Education, 2016.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	1	-	1	2	2	1	3	-	1	-	2	3
CO2	2	2	1	2	-	3	2	1	3	-	1	2	1	1
CO3	1	2	2	1	2	1	-	3	2	-	3	2	-	2
CO4	2	2	3	1	-	1	1	-	-	-	-	2	2	3
CO5	3	-	2	-	-	-	-	-	-	-	-	-	-	3

MT20604 **FLUID POWER AUTOMATION** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- acquire the concepts of fluid power.
- understand the fundamentals of hydraulic and pneumatic system.
- understand the working of various hydraulic circuits.
- understand the working of various pneumatic circuits.
- learn the concept of fluid logic control systems, maintenance of fluid power systems.

UNIT I FLUID POWER SYSTEMS **9**

Introduction to Fluid power - Advantages and Applications; Fluid Power ANSI Symbols; Types of fluids, Properties of fluids; Pascal's law and Applications; Darcy's equation; Frictional losses - Losses in valves and fittings; Basics of Hydraulics - Principles of flow; Pump Classification - Pump characteristics, Construction, Working, Performance, Selection criteria of pumps, Advantages, Disadvantages.

UNIT II HYDRAULIC ACTUATORS AND VALVES **9**

Hydraulic Actuators – Types, Construction, Application; Hydraulic Cushioning; Hydraulic motors; Control Components - Direction control, Flow control and Pressure control valves - Types, Construction and Operation; Servo and Proportional valves, Applications.

UNIT III HYDRAULIC SYSTEMS **9**

Intensifiers; Industrial hydraulic circuits - Regenerative, Pump Unloading, Double-pump, Pressure Intensifier, Air over oil, Reciprocation, Synchronization, Sequencing, Fail-safe, Speed Control, Hydrostatic transmission; Electro Hydraulic circuits.

UNIT IV PNEUMATIC SYSTEMS **9**

Properties of air; Perfect Gas Laws - Filter, Regulator, Lubricator; Pneumatic actuators; Sequential circuit design for simple applications - Step counter method, Cascade methods & Karnaugh Veitch map method; Electro pneumatic circuits; Accumulators - Types and applications.

UNIT V FLUID LOGIC CONTROL SYSTEMS AND MAINTENANCE **9**

Hydro Mechanical servo systems; Electro-hydraulic and Electro-pneumatic systems; Fluidic Logic and switching controls; PLC applications in fluid power control; Maintenance - Failure and trouble shooting in fluid power systems.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- illustrate symbols used in hydraulic and pneumatic systems.
- identify the appropriate components for hydraulic and pneumatic circuits.
- operate and maintain various pneumatic and hydraulic systems in industrial environments.
- design the hydraulic and pneumatic circuits for simple application.
- explain the concept of fluid logic control systems, maintenance of fluid power systems.

TEXT BOOKS

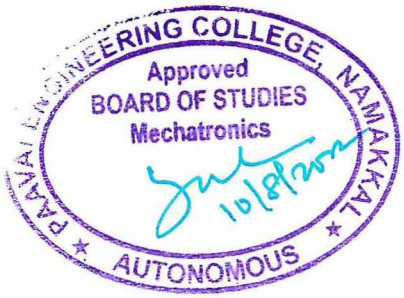
1. Anthony Esposito, "Fluid Power with Applications", 7th edition, Pearson Education Inc., 2016.
2. Cassi Piccuillo, "Pneumatic Systems: Principles And Maintenance: Pneumatic", Independently Published, 2021.

REFERENCES

1. James L. Johnson, "Introduction to Fluid Power", Delmar Thomson Learning, 2013.
2. Avinash G. Patil, Vinayak K. Gaikwad and Dr. Vikas V. Shinde, "Hydraulics and Pneumatics", 2nd edition, Technical Publications, 2019.
3. Ilango, Sivaraman, "Introduction to Hydraulics and Pneumatics", 3rd edition, PHI Learning, 2017.
4. S. R. Majumdar, "Oil Hydraulic Systems: Principles and Maintenance Hardcover", McGraw Hill Education 2017.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	-	-	2	1	3	2	2	-	-	3	1	-
CO2	1	-	-	-	2	1	-	2	-	2	-	3	1	-
CO3	1	-	-	-	2	1	-	2	-	2	-	3	1	-
CO4	1	-	-	-	1	1	3	2	-	2	-	3	1	-
CO5	2	-	-	-	3	1	3	2	2	2	2	2	1	-



MT20605 **PLC AND AUTOMATION LABORATORY** **0 0 2 1**

COURSE OBJECTIVES

To enable students to

- understand a clear view on Programmable Logic Controllers (PLC).
- acquire knowledge on PLC control principles and applications with field devices.
- learn the ladder diagrams for automatic control and monitoring.
- understand the interfacing of microcontroller with stepper motor.

LIST OF EXPERIMENTS

1. Study of Programmable Logic Controllers.
2. Sequential operation of pneumatic cylinders using PLC.
3. Hydraulic motor with timer using PLC.
4. Automate the tank water level control using PLC.
5. Automatic bottle filling process using PLC.
6. Traffic light controller.
7. Programming the material handling system.
8. Programming and control the lamp by timer.
9. Programming the linear actuation of hydraulic cylinder.
10. 8051 / 8031 Programming (addition and subtraction).
11. 8051 / 8031 Programming (multiplication and division).
12. Stepper motor interface.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- develop the PLC program for cylinder actuation and control.
- develop the PLC program for tank water level control and bottle filling process.
- implement traffic control using PLC.
- interface the microcontroller with stepper motor.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	1	2	2	1	2	1	2	-	2	2	2	1
CO2	3	1	2	1	3	2	-	1	3	-	1	3	2	2
CO3	2	-	3	1	3	1	-	3	2	-	-	2	1	2
CO4	2	1	1	1	3	2	2	2	2	-	2	2	-	1

MT20606 FLUID POWER SYSTEM LABORATORY 0 0 2 1

COURSE OBJECTIVES

To enable students to

- understand the role of pneumatic and hydraulic systems in a complex mechatronics system.
- analyze pneumatic and hydraulic circuits, and identify basic components.
- understand the concept of circuit design for hydraulic press.
- learn the basic pneumatic circuits design.

LIST OF EXPERIMENTS

1. Fluid power standards.
2. Study of hydraulics systems components.
3. Study of pneumatic systems components.
4. Design of pressure control of pneumatic circuit.
5. Design of meter in circuit.
6. Design of meter out circuit.
7. Design of speed control circuit for double acting pneumatic cylinder.
8. Design of hydraulic press circuit.
9. Design of hand operated pneumatic double acting cylinder using fluid power simulationsoftware.
10. Design of hydraulic cylinder reciprocating system using fluid power simulation software.
11. Design and testing of pneumatic double acting cylinder sequencing circuit (A+ B+ B- A-) using fluid power simulation software.
12. Design and testing of pneumatic double acting cylinder synchronization circuits (cylinders connected in series and parallel) using fluid power simulation software.
13. Design of pneumatic circuit for a drilling operation and simulate the operation in fluid power simulation software.
14. Design of hydraulic circuit for a pick and place operation using cascade method and simulate the operation.

TOTAL PERIODS 30

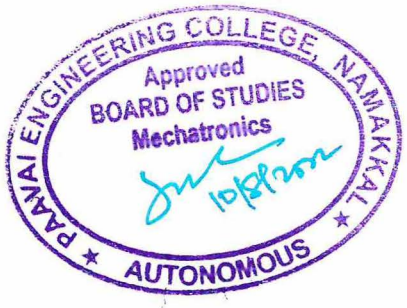
COURSE OUTCOMES

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

- find the experience of common hydraulic and pneumatic machine used in the industries.
- construct the fluid system for various applications.
- compare hydraulic, pneumatic and mechanical systems.
- design a hydraulic or pneumatic system circuit by using related software and make simulations.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	3	1	3	2	2	3	-	2	-	3	2	1	-
CO2	1	2	2	1	2	-	-	3	2	-	2	2	1	1
CO3	2	2	2	-	1	3	2	1	-	3	2	1	-	2
CO4	1	2	1	-	3	2	1	-	3	2	1	-	2	3



EN20601 **CAREER DEVELOPMENT LABORATORY II** **0 0 2 1**

COURSE OBJECTIVES

To enable students to

- draft resume and enhance their skills to manage stress to survive in corporate world.
- excel in interview skills.
- solve the quantitative aptitude problems and improve their problem-solving skills.
- improve their reasoning skills to get placed in reputed companies.

UNIT I RESUME WRITINGS **6**

Resume Writing Skills: Curriculum Vitae and Resume – Things to do while writing a Resume – Mistakes and Pitfalls to Avoid- Cover Letter: General Guidelines – The Content - Stress Management – Dressing Etiquette.

Activities: Corporate Resume Building Session I – JAM Session: Level III – Role Play Session (Individual): Level III - Company Profile Analysis Session III – Personality Profile Analysis Session III.

UNIT II INTERVIEW SKILLS **6**

Interview Skills: Introduction – Before the Interview – During the Interview – After the Interview – Types of Interview.

Activities: Presentation Session: Level II- Group Discussion Session: Level III ,Mock Interview Practice Session, Corporate Resume Building Session II.

UNIT III QUANTITATIVE APTITUDE **6**

Permutation and Combination – Probability: Dice, Colours, Coin, Cards ; Partnership – Ages – Calendars.

UNIT IV LOGICAL REASONING -I **6**

Making Judgments – Matching Definitions – Cause and Effect.

UNIT V LOGICAL REASONING II **6**

Directions – Syllogism – Analogy – Statements and Arguments.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- write resume and enhance their etiquettes.
- demonstrate the interpersonal skills in group discussions.
- compute problems based on quantitative aptitude.
- reveal their logical and verbal reasoning by scoring the expected percentage to get placed in reputed companies.

TEXTBOOKS

1. Agarwal, R.S." A Modern Approach to Verbal & Non Verbal Reasoning", S.Chand& Co Ltd, New Delhi, 2015.
2. Agarwal, R.S. " Objective General English", S.Chand & Co, 2016.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill, 2015.
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications, 2016.
3. Johnson, D.W. Reaching out – Interpersonal Effectiveness and self actualization. Boston: Allyn and Bacon., 2019.
4. Infosys Campus Connect Program – students' guide for soft skills, 2015.

CO/PO MAPPING:

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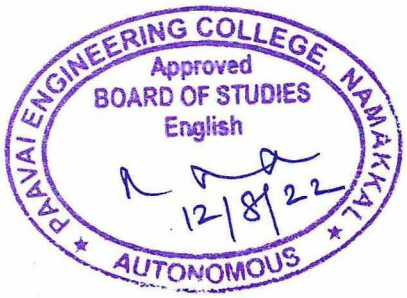


PROFESSIONAL ELECTIVE COURSES (PE)

PROFESSIONAL ELECTIVE – I

MT20151 **DIGITAL SIGNAL PROCESSING** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn the concepts of discrete Fourier transform, properties of DFT and FFT algorithms.
- know the characteristics and design of IIR filters.
- understand the characteristics of FIR filters for filtering the undesired signals.
- know the effects of Finite word length effects.
- study the concept of Digital signal processors and its implementation.

UNIT I DISCRETE FOURIER TRANSFORM AND FAST FOURIER TRANSFORM **9**

Review of signals and systems - Concept of frequency in discrete-time signals; Summary of analysis, synthesis equations for FT, DTFT - Frequency domain sampling; Review of DFT - Properties of DFT; FFT algorithms - Radix-2 FFT algorithm, Decimation in time, Decimation in frequency algorithms; Linear and circular convolution - Overlap add and save method.

UNIT II INFINITE IMPULSE RESPONSE FILTERS **9**

Characteristics of practical frequency selective filters - Characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters; Design of IIR filters from analog filters - LPF, HPF, BPF, BRF; Approximation of derivatives, Impulse invariance method, Bilinear transformation, Frequency transformation in the analog domain; Structure of IIR filter - Direct form I, Direct form II, Cascade, Parallel realizations.

UNIT III FINITE IMPULSE RESPONSE FILTERS **9**

Design of FIR filters - Symmetric and Anti-symmetric FIR filters, Design of linear phase FIR filters using Fourier series method; FIR filter design using windows - Rectangular, Hamming and Hanning window; Frequency sampling method; FIR filter structures - Linear phase structure, Direct form realizations.

UNIT IV FINITE WORD LENGTH EFFECTS **9**

Fixed point and floating-point number representation - ADC, quantization, truncation and rounding; Quantization noise - input / output quantization, coefficient quantization error, product quantization error, overflow error; Limit cycle oscillations - scaling to prevent overflow.

UNIT V DSP PROCESSORS AND ITS IMPLEMENTATION **9**

Introduction to programmable DSPs - TMS320C67xx, Architecture of C67X, C67X buses, Memory organization, CPU, ALU; Barrel shifter - Multiplier /adder unit, addressing modes, instruction set, application programs; Applications of DSP processors.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- apply DFT for the analysis of digital signals and systems.
- solve design problems in IIR filters.
- analyze the design of FIR filters.
- apply the concepts of finite word length effects in DSP processors.
- implement DSP algorithms in DSP processors.

TEXT BOOKS

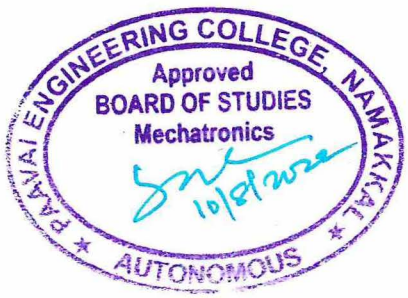
1. John G. Proakis & Dimitris G. Manolakis, "Digital Signal Processing - Principles, Algorithms and Applications", Fourth Edition, Pearson Education / Prentice Hall, 2007.
2. P. Ramesh Babu "Digital Signal Processing"- Fourth Edition- Scitech-2007.

REFERENCES

1. Emmanuel C. Ifeachor & Barrie. W. Jervis, "Digital Signal Processing", Second Edition Pearson Education Prentice Hall, 2002.
2. A.V. Oppenheim, R.W. Schafer and J.R. Buck, "Discrete-Time Signal Processing", 8th Indian Reprint, Pearson, 2004.
3. Sanjit K. Mitra, "Digital Signal Processing - A Computer Based Approach", Tata Mc Graw Hill, 2007.
4. Andreas Antoniou, "Digital Signal Processing", Tata Mc Graw Hill, 2006.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	-	-	-	-	-	-	-	-	-	-	1	-
CO2	2	2	1	1	2	-	-	-	-	-	-	-	2	1
CO3	2	2	3	2	2	-	-	-	-	-	-	-	3	-
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	-
CO5	1	-	2	-	-	-	-	-	-	-	-	-	2	1



MT20152 **ADVANCED MANUFACTURING PROCESSES** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand the several non - traditional machining processes in micro and precision manufacturing field.
- know the various casting processes.
- study the various welding process and their parameters.
- learn the metal forming processes in the field of production and testing.
- understand the basic fundamentals of rapid prototyping, its fabrication techniques, materials and various areas of defects and improvements in Rapid Prototyping.

UNIT I MACHINING PROCESSES **9**

Introduction; Classification; Process economy; Mechanical machining - Types - Ultrasonic machining (USM), Abrasive Jet Machining (AJM), Abrasive Flow Machining (AFM), Water Jet Machining (WJM) - Operating principle, Process parameters, Applications, Limitations.

UNIT II ADVANCED CASTING PROCESSES **9**

Metal mould casting; Continuous casting; Squeeze casting; Vacuum mould casting; Evaporative pattern casting; Ceramic shell casting.

UNIT III ADVANCED WELDING PROCESSES **9**

Details of Electron Beam Welding (EBW); Laser Beam Welding (LBW); Ultra Sonic Welding (USW).

UNIT IV ADVANCED METAL FORMING PROCESSES **9**

Details of high energy rate forming (HERF) process; Electro-magnetic forming; Explosive forming; Electro-hydraulic forming; Stretch forming; Contour roll forming.

UNIT V RAPID PROTOTYPING **9**

Tooling and Manufacturing; Classification of Rapid Prototyping (RP); Tooling (RT) and Manufacturing (RM) processes; Materials for RP/RT/RM; Operating principles, Characteristics and analysis of current and developing RP/RT/RM processes; Case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- apply advanced machining processes in the field of manufacturing industries.
- analyze the source for defects in casting processes.
- solve the issues related to material joining by adopting advanced welding processes.
- apply advanced forming processes in the field of production and testing.
- apply mechanism of chip formation in the processing of polymers, ceramics and composites.

TEXT BOOKS

1. P. N. Rao, "Manufacturing Technology - Foundry, Forming and Welding", 5th edition, McGraw Hill Education, 2018.
2. J. P. Kaushish, "Manufacturing Processes", Prentice Hall of India Learning Private Limited, New Delhi, 2014.

REFERENCES

1. Satish Chinchanikar, Sagar Dhage and Chittaranjan R More, "Advanced Manufacturing Processes", TechKnowledge Publications, 2020.
2. Groover, M.P. "Fundamentals of Modern Manufacturing Processes - Materials, Processes and Systems, 7th edition, Wiley, 2021.
3. Sudesh Garg and Keshav Jakhotia, "Non-Conventional Machining Methods", 3rd edition, Ashirwad, 2020.
4. Chua C.K., Leong K.F., and Lim C.S., "Rapid Prototyping: 3D Printing and Additive Manufacturing Principles and Applications", 5th edition, Chua, Chee Kai and K F Leong, 2019.

CO PO MAPPING:

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COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-	-	-

MT20153 DIAGNOSTIC TECHNIQUES 3 0 0 3

COURSE OBJECTIVES

To enable students to

- understand the various types of maintenance, their procedure and defects analysis commonly adopted in manufacturing industries.
- know the different types of maintenance.
- learn the procedures and guidelines on work permit system to carry out jobs of inspection, testing, maintenance, alternation, repair, upkeepment and construction in safest possible manner.
- know the usage of computers for maintenance management.
- understand the various condition monitoring techniques.

UNIT I DEFECTS AND FAILURE ANALYSIS 9

Maintenance Concept; Maintenance objective; Challenges in maintenance; Defect generation - Types of failures, Defect reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis; Breakdown analysis – FTA, FMEA, FMECA; Mechanisms of Wear - Detection of Wear Particles; Oil Sampling Technique - Oil Analysis, Limits of Oil Analysis.

UNIT II MAINTENANCE SYSTEMS 9

Types - Planned and un-planned maintenance, Breakdown maintenance, Corrective maintenance, Opportunistic maintenance, Routine maintenance, Preventive maintenance, Predictive maintenance, Condition based maintenance system; Design out maintenance - Maintenance by objectives, Selection of maintenance system.

UNIT III SYSTEMATIC MAINTENANCE 9

Codification and Cataloguing; Instruction manual, operating manual, Maintenance manual and departmental manual; Maintenance time standard; Maintenance work order and work permit; Job monitoring; Feedback and control system; Maintenance records and documentation; Introduction to Total Productive Maintenance (TPM).

UNIT IV COMPUTER MANAGED MAINTENANCE SYSTEM 9

Selection and scope of computerization; Equipment classification; Codification of breakdown, Material and facilities; Job sequencing; Material management module and captive engineering module; Decision making in maintenance; Economic aspects of maintenance; Maintenance features of CNC Machines.

UNIT V CONDITION MONITORING 9

Condition monitoring techniques - Visual monitoring, Temperature monitoring, Vibration monitoring, Lubricant monitoring, C racks monitoring, Thickness monitoring, Noise and sound monitoring; Cost comparison with and without CM; On - load testing and offload testing; Condition monitoring of hydraulic system; Machine diagnostics - Objectives, Monitoring strategies.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- analyze the defects and failures encountered in manufacturing system.
- classify the maintenance system and select suitable one based on requirement.
- identify the documentation and record updating involved in maintenance systems.
- utilize the computer to assist the maintenance system.
- establish the monitoring strategies according to system characteristics.

TEXT BOOKS

1. Keith Mobley, Lindley Higgins and Darrin Wikoff, "Maintenance Engineering Handbook", 8th edition, McGraw-Hill Education, 2014.
2. M. P. Poonia and S. C. Sharma, "Industrial Safety and Maintenance Management", 1st edition, Khanna Book Publishing, 2019.

REFERENCES

1. Alakesh Manna, "A Textbook of Reliability and Maintenance Engineering ", Dreamtech Press, 2020.
2. Mishra R.C., Pathak K. "Maintenance Engineering and Management", Prentice Hall India Learning Private Limited, New Delhi, 2012.
3. George Hartnett, "Handbook of Maintenance Management and Maintenance Engineering: Principles and Practices", Anmol Publications, 2012.
4. D. R. Kiran, "Maintenance Engineering and Management: Precepts and Practices", 2nd edition, Biotech Books, 2017.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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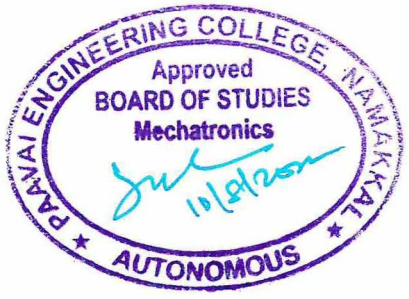
CO1	3	3	-	-	-	-	-	-	-	-	-	-	1	-
CO2	2	2	1	1	2	-	-	-	-	-	-	-	2	1
CO3	2	2	3	2	2	-	-	-	-	-	-	-	3	-
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	-
CO5	1	-	2	-	-	-	-	-	-	-	-	-	2	1



MT20154 PRODUCT DESIGN AND COSTING 3 0 0 3

COURSE OBJECTIVES

To enable students to

- know the several aspects of the design process.
- study the concept of product costing, patenting and manufacturing economics in product design.
- understand the elements of economics in product development.
- learn the functional requirements, product materials and product design.
- acquire the knowledge about manufacturing process selection.

UNIT I PRODUCT DESIGN AND PLANNING 9

Product planning - identifying opportunities - allocating resources and timing - pre-project planning - reflect on the results and the process - identifying customer needs - raw data from customers - interpreting raw data in terms of customer needs - organizing the needs into a hierarchy – establishing the relative importance of the needs -reflecting on the results and the process.

UNIT II PRODUCT SPECIFICATIONS AND CONCEPT GENERATION 9

Specifications - specifications established - establishing target specifications - setting the final specifications - concept generation - the activity of concept generation - clarify the problem – external search - internal search - systematic exploration - reflect on the results and the process.

UNIT III PRODUCT DEVELOPMENT ECONOMICS 9

Elements of economic analysis - quantitative analysis, qualitative analysis - building a base - case financial model - sensitivity analysis - development cost and time with examples - project trade-offs - six potential, trade off rules, limitations - influence of qualitative factor on project success – qualitative analysis.

UNIT IV COST ESTIMATION 9

DFM Cross functional team - estimate the manufacturing cost, reduce the cost of components, reduce the cost of assembly, rescue the cost of supporting production - impact of DFM decisions - development time, development cost, product quality, external factors.

UNIT V PATENTS AND INTELLECTUAL PROPERTY 9

Overview of patents, utility patents, preparing a disclosure - formulate strategy plan- study of prior invention- outline claims - description of inventions - refine claims - pursue application - reflect of result and process.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify the customer requirements to start new project and carryout product planning.
- generate and select suitable ideas to pursue successful design.
- quantify and access the manufacturing process and cost to make well defined component.
- express the process of patenting the intellectual property.
- apply the economic reasoning to analysis the contemporary problem for newly developed product.

TEXT BOOKS

1. Karl T. Ulrich, Steven D. Eppinger and Maria C. Yang, "Product Design and Development", 7th edition, McGraw Hill Education (India) Private Limited, (2020).
2. Steven Selikoff, "The Complete Book of Product Design, Development, Manufacturing, and Sales", 2nd edition, Product Development Academy, 2020.

REFERENCES

1. Linda C. Schmidt and George Dieter, "Engineering Design", 4th edition, McGraw Hill Education, 2017.
2. S. Dalela and Mansoor Ali, "Industrial Engineering and Management Systems", Standard Publishers Distributors Pvt. Ltd., New Delhi, 2010.
3. Dr. Vijayendra Kumar Shrivastava and Dr. Pradeep Kumar Mishra. "Industrial Management and Entrepreneurship ", 1st edition, Mahaveer Publications, 2020.

CO PO MAPPING:

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COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	-	-	1	2	3	1	2	-	3	2	1	2
CO2	2	-	-	-	1	2	2	2	2	-	2	2	-	2
CO3	1	-	-	-	1	2	2	1	-	-	2	1	-	1
CO4	1	-	-	-	1	2	1	2	2	-	1	-	2	2
CO5	1	-	-	-	1	2	2	1	2	-	1	-	-	3

PROFESSIONAL ELECTIVE - II

IT20256 COMPUTER COMMUNICATION NETWORKS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the division of network functionalities into layers.
- familiar with the components required to build different types of networks
- analyze the various routing protocols.
- learn the flow control and congestion control algorithms
- acquire knowledge of new application using application layer.

UNIT I FUNDAMENTALS & PHYSICAL LAYER 9

Introduction - Data communications, Networks, Network models; Layer tasks - The OSI Model, Layers in the OSI model, TCP/IP protocol suit; Overview of Data and signals; Transmission media; Switching.

UNIT II DATA LINK LAYER 9

Error detection and correction; Data link control - Framing, HDLC; Multiple Access; Wired LANs - Standard Ethernet, Fast Ethernet, Gigabit Ethernet; Wireless LANs - IEEE 802.11, Bluetooth; Connecting Devices.

UNIT III NETWORK LAYER 9

Logical addressing - IPv4 Addresses, IPv6Addresses; Internet protocol - Internetworking (IPv4, IPv6), Transitions from IP4 to IP6; ICMP; IGMP; Forwarding; Unicasting routing protocol; Multi casting routing protocol.

UNIT IV TRANSPORT LAYER 9

Duties of Transport Layer; User datagram protocol (UDP); Transmission control protocol (TCP) - Connection establishment, Connection release; Congestion control; Quality of Service - Techniques to Improve QoS.

UNIT V APPLICATION LAYER 9

Electronic Mail (SMTP, POP3, IMAP, MIME); File Transfer Protocol; WWW; HTTP; DNS; SNMP.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the basic layers and its functions in computer networks.
- design and analyze error and flow control algorithms for communication between adjacent nodes in a network.
- identify and apply the suitable routing algorithms for the given network.
- develop a client/server application using TCP/UDP and design algorithms for end-end communication.
- analyze the capabilities of application layer utilities and replicate the same for new applications.

TEXT BOOKS

1. Behrouz A. Forouzan, "Data Communication and Networking", Fifth Edition, Tata McGraw -Hill, 2015.
2. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach", Sixth Edition, Pearson Education, New Delhi 2017

REFERENCES

1. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.
2. Andrew S Tanenbaum and David J Wetherall, "Computer Networks", Fifth Edition, Pearson Education, 2012.
3. Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill Publisher, 2011.
4. William Stallings, "Data and Computer Communications", 10th Edition, PHI, New Delhi 2015.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes (3/2/1 indicates strength of correlation) 3-Strong,2-Medium,1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	3	-	2	-	-	-	-	2	1	2	3	2
CO2	1	2	3	1	1	-	-	-	-	2	2	2	3	2
CO3	3	2	3	-	-	-	-	-	-	-	2	2	3	2
CO4	1	3	2	2	2	-	-	-	-	-	2	2	3	2
CO5	3	2	-	2	2	-	-	-	-	2	1	2	3	3

MT20251 **ENGINEERING ECONOMICS AND COST ANALYSIS** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn the fundamentals of demand and supply.
- understand and apply methods of cost analysis.
- know the types of banking and its functions.
- understand the concepts of depreciation and cost analysis.
- learn the method adopted for capital budgeting.

UNIT I DEMAND AND SUPPLY ANALYSIS **9**

Definition and scope of study - importance of economic analysis - demand and supply analysis - demand determinants - Law of demand - elasticity of demand - law of supply - elasticity of supply - demand forecasting methods; Concept of Just-in-Time production; Cost of Goods Sold (COGS): Definition - Accounting methods - Cost of Revenue vs. COGS - Operating Expenses vs. COGS - Limitations of COGS.

UNIT II COST ANALYSIS **9**

Types of cost - Fixed cost- variable cost - marginal cost - pricing decisions - pricing techniques in practice - full cost - pricing - marginal cost pricing - going rate pricing - bid pricing - price fixing for a rate of return

UNIT III MONEY AND BANKING **9**

Value of money - inflation, deflation; Banking - commercial bank and its functions - central bank and its functions; New economic environment - globalization - liberalization and privatization.

UNIT IV DEPRECIATION AND COST ANALYSIS **9**

Causes of depreciation - objectives - methods of computing depreciation - simple problems; Breakeven analysis - breakeven point - breakeven chart - uses of breakeven analysis; Balance sheet.

UNIT V CAPITAL BUDGETING **9**

Need for capital budgeting - rate of return method - payback period method - present value comparisons method - cost benefit analysis; Preparation of feasibility report - economic and commercial feasibility - financial feasibility - technical feasibility.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- acquire knowledge to the major concepts and techniques of engineering economic analysis.
- carryout the supply of material and demand of products in their management profession.
- gain adequate knowledge on banking system.
- perform demand forecasting, cost analysis, pricing and financial accounting for an engineering industry.
- carryout cost analysis for capital subjecting based on depreciation money available.

TEXT BOOKS

1. Panneerselvam R, "Engineering Economics", 2nd revised edition, Prentice Hall India Learning Private Limited, 2013.
2. Chan S.Park, "Contemporary Engineering Economics", 6thEdition, PHI Learning Private Limited, New Delhi, 2015.

REFERENCES

1. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and Analysis" Engg. Press, Texas, 2010.
2. Patel Bhavesh. M, "Project Management: Financial Evaluation with Strategic Planning, Networking and Control ", 2nd edition, Vikas Publishing House, New Delhi, 2010.
3. Michael Baye and Jeff Prince, " Managerial Economics and Business Strategy ", Tata McGraw Hill, 2013.
4. Paul Samuelson and William Nordhaus, "Economics", Tata McGraw Hill, 19th edition, 2010.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	1	-	2	-	2	-	-	-	-	-	1	2
CO2	-	-	2	-	-	1	2	-	-	1	1	1	2	1
CO3	-	1	-	2	1	-	2	1	1	-	-	-	1	-
CO4	2	-	-	1	3	-	1	-	-	-	-	2	-	2
CO5	2	1	-	1	-	-	-	-	-	1	-	-	2	1

MT20252 **DESIGN OF JIGS, FIXTURES AND PRESS TOOLS** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- acquire the knowledge about locating and clamping devices.
- understand the principles, functions and design practices of jigs and fixtures.
- gain knowledge on progressive and compound dies.
- learn the concept of die design for given simple components using different operations.
- gain knowledge on various forming technique.

UNIT I LOCATING AND CLAMPING PRINCIPLES **9**

Objectives of tool design- Function and advantages of Jigs and fixtures - Basic elements - principles of location - Locating methods and devices - Redundant Location - Principles of clamping - Mechanical actuation – pneumatic and hydraulic actuation Standard parts - Drill bushes and Jig buttons - Tolerances and materials used.

UNIT II JIGS AND FIXTURES **9**

Design and development of jigs and fixtures for given component- Types of Jigs - Post, Turnover, Channel, latch, box, pot, angular post jigs - Indexing jigs - General principles of milling, Lathe, boring, broaching and grinding fixtures - Assembly, Inspection and Welding fixtures - Modular fixturing systems- Quick change fixtures.

UNIT III PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES **9**

Press Working Terminologies - operations - Types of presses - press accessories - Computation of press capacity - Strip layout - Material Utilization - Shearing action - Clearances - Press Work Materials - Center of pressure- Design of various elements of dies - Die Block - Punch holder, Die set, guide plates - Stops - Strippers - Pilots - Selection of Standard parts - Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

UNIT IV BENDING AND DRAWING DIES **9**

Difference between bending and drawing - Blank development for above operations - Types of Bending dies - Press capacity - Spring back - knockouts - direct and indirect - pressure pads - Ejectors - Variables affecting Metal flow in drawing operations - draw die inserts - draw beads-ironing - Design and development of bending, forming, drawing, reverse redrawing and combination dies - Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

UNIT V FORMING TECHNIQUES AND EVALUATION **9**

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies - recent trends in tool design- computer Aids for sheet metal forming Analysis - basic introduction - tooling for numerically controlled machines- setup reduction for work holding - Single minute exchange of dies - Poka Yoke.

TOTAL PERIODS 45

Note: (Use of P S G Design Data Book is permitted in the University examination)

COURSE OUTCOMES

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

- summarize the different methods of locating jigs and fixtures and clamping principles.
- design and develop jigs and fixtures for given component.
- discuss the press working terminologies and elements of cutting dies.
- distinguish between bending and drawing dies.
- discuss the different types of forming techniques.

TEXT BOOKS

1. Edward Hoffman, "Jigs and Fixture Design, Cengage India, 5th edition, 2018.
2. Joshi, P.H., "Jigs and Fixtures", McGraw Hill Education; 3rd edition, 2017.

REFERENCES

1. K. Venkataraman, "Design of Jigs, Fixtures and Press Tools", Wiley-Blackwell, 2nd edition, 2015.
2. Cyril Donaldson, George H. Lecain and VC Goold "Tool Design", McGraw Hill Education, 4th edition, 2012.
3. V.Balachandran, "Design of Jigs, Fixtures and Press Tools" Notion Press, 1st edition, 2015.
4. John Nee, "Fundamentals of Tool Design", Society of Manufacturing Engineers, 6th edition, 2010.
5. Roop Lal, "Jig and Fixtures Design", Vayu Education of India, 2015.

CO PO MAPPING:

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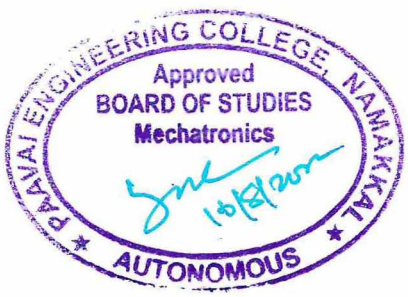
CO2	2	-	-	-	-	-	-	-	2	2	-	-	2	-
CO3	2	-	-	-	-	-	-	-	2	2	-	-	2	-
CO4	2	-	-	-	-	-	-	-	2	2	-	-	2	-
CO5	1	-	-	-	-	-	-	-	2	2	-	-	2	-



MT20253 **ADDITIVE MANUFACTURING** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand the need, history, growth and classification of additive manufacturing.
- learn the design process for additive manufacturing.
- know the principle, process parameters, applications of SLA, SLS and EBM.
- learn the principle, process parameters, applications of FDM and LOM.
- understand the principle, process parameters, applications of Three-Dimensional Printing.

UNIT I INTRODUCTION TO ADDITIVE MANUFACTURING **9**

Introduction to AM - AM evolution, Distinction between AM and CNC machining; Steps in AM, Classification of AM processes, Advantages of AM; Types of materials for AM.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING **9**

Concepts and Objectives -AM Unique Capabilities; Part Consolidation -Topology Optimization, Lightweight Structure, DFAM for Part Quality Improvement; Data Processing - CAD Model Preparation, Part Orientation and Support Structure Generation, Model Slicing, Tool Path Generation; Customized Design and Fabrication for Medical Applications.

UNIT III PHOTO POLYMERIZATION AND POWDER BED FUSION PROCESSES **9**

Photo polymerization – SLA, Photo curable materials, Process, Advantages and Applications; Powder Bed Fusion – SLS, Process description, Powder fusion mechanism, Process Parameters, Typical Materials and Application; Selective Laser Melting (SLM) and Electron Beam Melting (EBM) – Materials, Process, Advantages and Applications.

UNIT IV EXTRUSION BASED AND SHEET LAMINATION PROCESSES **9**

Extrusion Based System – FDM, Introduction, Basic Principle, Materials, Applications and Limitations; Bio extrusion; Sheet Lamination Process – LOM, Gluing or Adhesive bonding, Thermal bonding, Materials, Application and Limitation.

UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES **9**

Droplet formation technologies - Continuous mode, Drop on Demand mode; Three-Dimensional Printing – Advantages, Bio plotter; Beam Deposition Process - LENS, Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition - Process description, Material delivery, Process parameters, Materials, Benefits, Applications.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- apply the basics of additive manufacturing techniques in manufacturing.
- design a prototype the models of real-world engineering parts.
- apply powder based rapid prototyping system in suitable applications.
- apply FDM and LOM process in suitable applications.
- develop the various printer models using RP process.

TEXT BOOKS

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid Prototyping: 3D Printing and Additive Manufacturing Principles and Applications", 5th edition, Chua, Chee Kai and K F Leong, 2019.
2. Ravikumar B and Satyabodh M Raichuru "Additive Manufacturing" Sunstar Publisher, 2020.

REFERENCES

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", 1st edition, Hanser Gardner Publication, 2012.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Reprint of 1st edition, Springer, 2015.
3. Ian Gibson, David Rosen, Brent Stucker and Mahyar Khorasani, "Additive Manufacturing Technologies", 3rd edition, Springer, 2020.
4. G. K. Awari, C. S. Thorat, Vishwjeet Ambade and D. P. Kothari "Additive Manufacturing and 3D Printing Technology: Principles and Applications", 1st edition, CRC Press, 2021.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	2	-	1	-	-	-	-	-	-	-	-	-	1	1
CO3	2	-	1	-	-	-	-	-	-	-	-	-	1	1
CO4	2	-	1	-	-	-	-	-	-	-	-	-	1	1
CO5	2	-	1	-	-	-	-	-	-	-	-	-	1	1

OPEN ELECTIVE COURSES (OE)

OPEN ELECTIVE – I

MT20901 **NON - DESTRUCTIVE TESTING** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn the concept of visual inspection and penetrants testing.
- understand the principles of advanced techniques of NDT.
- know the appropriate ultrasonic scanning techniques.
- acquire knowledge on defects through radiography method.
- learn the crack propagation through acoustic emission and eddy current testing.

UNIT I VISUAL INSPECTION AND LIQUID PENETRANTS TESTING **9**

Introduction to Various Non - Destructive Methods; Comparison of Destructive and Non - Destructive Tests; Visual Inspection - Optical Aids used for Visual Inspection, Applications; Physical Principles - Procedure for Penetrate Testing, Penetrant Testing Materials, Penetrant Testing Methods, Water Washable, Post Emulsification Methods, Applications.

UNIT II MAGNETIC PARTICLE TESTING AND THERMOGRAPHY **9**

Principle of Magnetic Particle Testing (MPT) - Procedure used for Testing a Component, Equipment used for MPT, Magnetizing Techniques, Applications; Principle of Thermography - Infrared Radiometry - Measurements, Applications; Imaging Entrapped Water Under an Epoxy Coating.

UNIT III ULTRASONIC TESTING **9**

Principle; Ultrasonic Transducers; Ultrasonic Flaw Detection Equipment; Modes of Display A-Scan, B-Scan, C-Scan, Applications; Inspection Methods - Normal Incident Pulse, Echo Inspection, Normal Incident Through Transmission Testing, Applications of Normal Beam Inspection in Detecting Fatigue Cracks.

UNIT IV RADIOGRAPHY **9**

Principle; Interaction of X-Ray with matter, Imaging, Film and film less techniques, Types and use of filters and screens; Geometric factors; Inverse square law; Characteristics of films - Graininess, Density, Speed, Contrast, Characteristic curves; Penetrometers; Exposure charts; Radiographic equivalence; Fluoroscopy; Xero Radiography; Computed Radiography; Computed Tomography.

UNIT V ACOUSTIC EMISSION AND EDDY CURRENT **9**

Principle of AET - Instrumentation, Applications; Testing of Metal Pressure Vessels; Fatigue Crack Detection in Aerospace Structures; Principles - Instrumentation for ECT; Technique - High Sensitivity Techniques, Multi Frequency, Phased Array ECT, Applications; Case Studies on Defects in Cast, Rolled, Extruded, Welded and Heat Treated Components.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- apply surface NDT techniques to carry out various inspection in accordance with the established procedures.
- examine the defects through thermography and magnetic particle method.
- interpret the various internal defects of the manufacturing product through ultrasonic method.
- choose right radiographic techniques and X-Rays for testing.
- analyze the crack propagation through acoustic emission and eddy current testing.

TEXT BOOKS

1. Mr. T.Raja Santhosh Kumar, Dr. A. Anderson, and Dr. S.Ramachandran, "Non - Destructive Testing", 1st edition, Airwalk Publications, 2017.
2. Peter J. Shull, "Non-Destructive Evaluation: Theory-Techniques and Applications", 1st edition, CRC Press, 2002.

REFERENCES

1. J Prasad and C G K Nair, Non-Destructive Testing and Evaluation of Materials, 2nd edition, McGraw Hill Education, 2017.
2. Sadashiva M, "Non-Destructive Testing", 1st edition, Notion Press, 2021.
3. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age Publications, New Delhi, 2010.
4. Wong B Stephen, "Non-Destructive Testing - Theory, Practice and Industrial Applications", LAP Lambert Academic Publishing, 2014.

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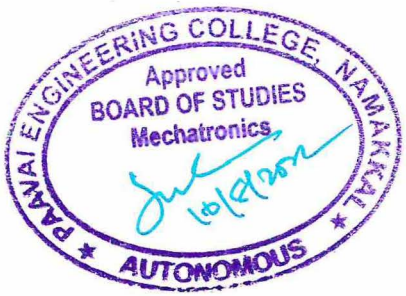
CO1	2	3	1	3	2	2	3	-	2	-	3	2	1	-
CO2	-	3	2	1	2	-	-	3	2	-	2	2	-	1
CO3	3	3	2	-	1	2	2	1	-	3	2	1	-	2
CO4	3	2	1	-	2	2	1	-	3	2	1	-	2	3
CO5	2	1	-	-	-	3	2	1	3	2	1	-	-	-



MT20902 **MOBILE AND AUTONOMOUS ROBOTS** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn the basic concepts of mobile robot and its types.
- study various types of mobile robot locomotion.
- understand the mobile robot kinematics and constraints.
- acquire knowledge on sensors for the perception of mobile robots.
- know the various application of service and industrial autonomous robotic system.

UNIT I INTRODUCTION **9**

Tele-operated Robot; Master and slave; Autonomous Robot - Components of autonomous robotic system, Challenges in autonomous robot, Redundant manipulator, Types of autonomous robotic system.

UNIT II LOCOMOTION **9**

Types of locomotion; Key issues in locomotion; Wheeled mobile robot – Types of wheel, Wheel stability, Wheel configurations; Biomimetic locomotion.

UNIT III MOBILE ROBOT KINEMATICS **9**

Forward and inverse kinematics; Holonomic and non-holonomic constraints; Kinematic models of simple car and legged robots; Simulation of mobile robots.

UNIT IV ROBOT PERCEPTION **9**

Proprioceptive/Exteroceptive and passive/active sensors; Performance measures of sensors; Sensors for mobile robots like global positioning system (GPS); Doppler effect-based sensors; Vision-based sensors; Uncertainty in sensing and filtering.

UNIT V MULTI ROBOTS AND ITS APPLICATION **9**

Leader based multi robot system; Leader less mobile robot system; Task allocation; Fault tolerance; Swarm robotics; Applications - Military mobile robots, Underwater robots, Service robot, Surveillance robots, Nano robots; Case study.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- predict the various types of autonomous system and its challenges.
- identify the types of locomotion and its kinematic constrain.
- apply mobile robot kinematics and constraints.
- choose sensors for the perception of mobile robots.
- discuss various application of service and industrial autonomous robotic system.

TEXT BOOKS

1. Roland Seigwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, "Introduction to autonomous mobile robots", 2nd edition, MIT Press, 2011.
2. Gregory Dudek and Michael Jenkin, "Computational Principles of Mobile Robotics", 2nd edition, Cambridge University Press, 2010.

REFERENCES

1. Shuzhi Sam Ge, "Autonomous Mobile Robots: Sensing, Control, Decision making and Applications", CRC Press, Taylor and Francis Group, 2006.
2. Bruno Siciliano and OussamaKhatib, "Handbook of Robotics", 2nd edition, 2016, Springer. ISBN: 9783319325507.
3. Jitendra R. Rao and Ajith K. Gopal, "Mobile Intelligent Autonomous Systems", CRC Press, Taylor and Francis Group. ISBN: 9781439863008, 2012.

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