PAAVAI ENGINEERING COLLEGE

(AUTONOMOUS)

B.E. MECHATRONICS ENGINEERING

REGULATIONS 2016

(CHOICE BASED CREDIT SYSTEM)

CURRICULAM

(For the candidates admitted during the Academic Year 2017 - 2018)

SEMESTER V

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	MT16501	Design of Machine Elements	3	2	0	4
2	ES	EE16503	Power Electronics	3	0	0	3
3	PC	MT16502	Sensors and Instrumentation	3	0	0	3
4	PC	MT16503	CNC Technology	3	0	0	3
5	HS	CH16501	Environmental Science and Engineering	3	0	0	3
6	PE	MT1615*	Programme Elective - I *	3	0	0	3
Practical							
7	ES	EE16508	Power Electronics Laboratory	0	0	4	2
8	PC	MT16504	Sensors and Instrumentation Laboratory	0	0	2	1
9	PC	MT16505	CNC Programming Laboratory	0	0	2	1
10	EE	EN16501	Career Development Laboratory I	0	0	2	1
			Total	**18**	**2**	**10**	**24**

SEMESTER VI

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	HS	BA16151	Professional Ethics and Human Values	3	0	0	3
2	PC	MT16601	PLC and Automation	3	0	0	3
3	PC	MT16602	Hydraulics and Pneumatics	3	0	0	3
4	PC	MT16603	Thermodynamics and Heat Transfer	3	2	0	4
5	ES	IT16305	Object Oriented Programming with C++	3	0	0	3
6	OE	MT1690*	Open Elective - I*	3	0	0	3
Practical							
7	PC	MT16604	PLC and Automation Laboratory	0	0	2	1
8	ES	IT16307	Object Oriented Programming with C++ Laboratory	0	0	4	2
9	PC	MT16605	Hydraulics and Pneumatics Control Laboratory	0	0	2	1
10	EE	EN16601	Career Development Laboratory II	0	0	2	1
			Total	**18**	**2**	**10**	**24**

PROGRAMME ELECTIVE (PE)

PROGRAMME ELECTIVE - I

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	MT16151	Advanced Manufacturing Processes	3	0	0	3
2	PE	MT16152	Digital Signal Processing	3	0	0	3
3	PE	MT16153	Diagnostic Techniques	3	0	0	3
4	PE	MT16154	Modelling and Simulation in Engineering	3	0	0	3
5	PE	MT16155	Product Design and Costing	3	0	0	3

OPEN ELECTIVES (OE)

S. No	Category	Course Code	Course Title	L	T	P	C
1	OE	MT16901	Industrial Engineering	3	0	0	3
2	OE	MT16902	Mechatronics	3	0	0	3
3	OE	MT16903	Micro Electro Mechanical Systems	3	0	0	3
4	OE	MT16904	Biomedical Instrumentation	3	0	0	3
5	OE	MT16905	Non-Destructive Testing	3	0	0	3

SEMESTER V

MT16501	**DESIGN OF MACHINE ELEMENTS**	**3**	**2**	**0**	**4**
	(Use of PSG Design Data Book is permitted)				

COURSE OBJECTIVES

To enable the students to

- describe the various steps involved in the design process.
- identify the principles involved in evaluating the shape and dimensions of a component and to satisfy functional and strength requirements.
- propose the standard practices and standard data.
- extend the uses of catalogues and standard machine components.
- design the simple machine elements shaft, coupling, joint, lever, spring, flywheel and bearing.

UNIT STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 15

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties - Direct, Bending and Torsional stress equations - Impact loading - Calculation of principle stresses for various load combinations- Design of curved Beams - Crane hook and C frame - Factor of safety - The theories of failure.

UNIT II DESIGN OF SHAFTS AND COUPLINGS 15

Design of solid and hollow shafts based on strength, rigidity and critical speed - Design of keys and key ways - Design of rigid and flexible couplings - Muff, Clamp, Rigid Flange, Bushed - pin flexible couplings.

UNIT III DESIGN OF JOINTS 15

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints - Welded joints, Riveted joints for structures - theory of bonded joints.

UNIT IV DESIGN OF SPRINGS AND FLYWHEEL 15

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 - Design of flywheels involving Stresses in rim and arm.

UNIT V DESIGN OF BEARINGS 15

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings - Somerfield Number - Raimondi and Boyd graphs - Selection of Rolling Contact bearings.

TOTAL PERIODS 75

COURSE OUTCOMES

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

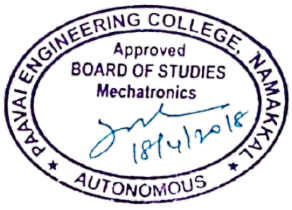
- acquire knowledge about design process and the factors influencing it and design the simple components for static loading.
- categories the knowledge of life of the components subjected to varying loads.
- encompass grasped the concept the welded joints, threaded joints and springs subjected to static loads.
- formulate the design procedure for springs and flywheel.
- understand the rolling contact bearings for static and cyclic loads, select the lubricants and bearing dimensions for hydrodynamic lubrication.

TEXT BOOKS

1. Bhandari V, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co, (2010).
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, (2008).

REFERENCES

1. Sundararajamoorthy T. V. Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, (2003).
2. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, (2005).
3. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill Book Co (2011).
4. Bernard Hamrock, Steven Schmid,Bo Jacobson, "Fundamentals of Machine Elements",2nd Edition, Tata McGraw-Hill Book Co., (2006).
5. Orthwein W, "Machine Component Design", Jaico Publishing Co, (2003).



WEB LINKS

1. https://mech.iitm.ac.in/meiitm/course/design-of-machine-elements/
2. http://www.readorrefer.in/article/Design-of-Shafts-and-Couplings-5901/
3. https://www.rroij.com/open-access/design-and-development-of-dual-mass-flywheel system.php?aid=54289

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

EE16503 POWER ELECTRONICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- access knowledge on different types of power semi-conductor devices and their switching characteristics.
- identify with the operation of converter and their firing circuits and different commutation techniques of power converters.
- identify with the operation of various chopper conversion techniques and basics of resonance converter.
- propose the mode of inverters and different modulation techniques.
- propose the types of ac voltage controllers and basics of matrix converters.

UNIT I POWER SEMICONDUCTOR DEVICES 9

Study of switching devices, Diode, SCR, TRIAC, GTO, BJT, MOSFET, IGBT-Static and Dynamic characteristics - Commutation: Natural Commutation, Forced commutation, self-commutation. snubber circuit.

UNIT II PHASE-CONTROLLED CONVERTERS 9

2-pulse, 3-pulse and 6-pulseconverters- performance parameters -Effect of source inductance-- Gate Circuit schemes for Phase Control-Dual converters.

UNIT III CHOPPER 9

Step-down and step-up chopper - control strategy - Forced commutated chopper -Voltage commutated, Current Commutated, switched mode regulators - Buck, boost, buck- boost converter. Introduction to Resonant Converters.

UNIT IV INVERTERS 9

Single phase and three phase voltage source inverters (both 120^0mode and 180^0mode) - PWM techniques: Current sinusoidal PWM, modified sinusoidal PWM - multiple PWM - Introduction to space vector modulation - Source inverter - Introduction to multilevel inverter.

UNIT V AC VOLTAGE CONTROLLERS 9

Single phase and Three phase AC voltage controllers - Control strategy - Power Factor Control - Multistage sequence control - single phase and three phase cyclo converters - Introduction to Matrix converters.

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.
- investigate the different converter based on the application.
- design a suitable dc power supply for given load specification from dc supply.
- design and analyze the single and three phase inverter.
- design an ac voltage controller electromagnetic compatibility of power converters.

TEXT BOOKS

1. M.H.Rashid, Power Electronics: Circuits, Devices Applications, Pearson, 2013.
2. M.D. Singh and Khanchandani K.B., Power Electronics, Tata McGraw Hill., 2016.
3. P. S. Bimbra, Power Electronics, Khanna Publishers, New Delhi, 2012.

REFERENCES

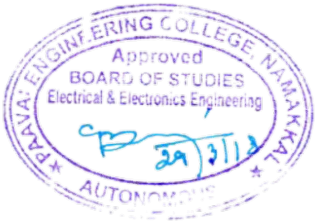
1. L.Umanand, Power Electronics Essentials and Applications, Wiley India Pvt Ltd,Reprint,2010.
2. G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, Thyristorised Power Controllers, New Age International Publishers, 2012.
3. Ned Mohan,Tore M. Undeland and William P.Robins, Power Electronics - Converters, Applications and design Third Edition, John Wiley and Sons, 2008.
4. R.S. Ananda Murthy and V. Nattarasu, Power Electronics: A Simplified Approach, Pearson/Sanguine Technical Publishers, 2009.
5. Daniel W.Hart, Power Electronics, McGraw-Hill Publishing Company Ltd, 2011.

WEB LINKS

1. http://www.completepowerelectronics.com/
2. http://www.irf.com/

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	-	-	-	-	-	-	-	-	3	2
CO2	3	3	3	3	-	-	-	-	-	-	-	-	3	2
CO3	3	3	3	3	-	-	-	-	-	-	-	-	3	2
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	2
CO5	3	3	3	3	-	-	-	-	-	-	-	-	3	2



MT16502 SENSORS AND INSTRUMENTATION 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- achieve a knowledge of the basic laws governing the operation of electrical instruments and the measurement techniques.
- discuss about units, standards, error analysis and characteristics of measurement systems.
- plan and purpose of this course is to a make the students to get adequate knowledge about virtual instrumentation.
- learn a signal conditioning circuit and data acquisition system.
- understand the program for various applications of lab view and DAQ card.

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; Level conversion Linearization ; Buffering; Sample and Hold circuit; Analog to Digital converter; Digital to Analog converter; Data Acquisition; Data Logging; Data conversion; Introduction to Digital Transmission system.

UNIT V VIRTUAL INSTRUMENTATION 9

Introduction to Lab VIEW; Graphical user interfaces; Data types; Data flow programming; Graphical programming; Palettes and tools Front panel objects; Functions and libraries; FOR Loops; WHILE Loops; Arrays and Clusters; Data acquisition using DAQ card.

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.
- construct the lab view program for various applications and to know the use of lab view and DAQ card.

TEXT BOOKS

1. A.K.Sawhney and P.Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2011.
2. Garry M. Johnson, Labview Graphical Programming, Tata McGraw; Hill Publishing Company Limited, New Delhi, 2006.

REFERENCES

1. D. Patranabis, “Sensors and Transducers”, PHI, New Delhi, 2nd Edition, 2010.
2. Ernest O. Doebelin, “Measurement Systems - Applications and Design”, Tata McGraw-Hill, 2009.
3. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011.

WEB LINKS

1. http://www.mfg.mtu.edu/cyberman/machtool/machtool/sensors/fundamental.html
2. http://sensorsandinstrumentation.co.uk/

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	-	2		2	-		2	2	-		2
CO2	3	3	-	-	-		2	1		2	2	-	-	0
CO3	-	3	2		1		-	2		-	2	1	-	2
CO4	3	3	2		1		2	1		3	2	1	-	2
CO5	-	3	2		1	-	-	1		-	2	2	-	2

MT16503 **CNC TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- identify the evolution and principle of CNC machine tools.
- describe the constructional features of CNC machine tools.
- construct the simple programs for CNC turning and machining centers.
- describe the tooling and work holding devices for CNC machine tools.
- explain the CNC programs for popular CNC controllers.

UNIT I INTRODUCTION TO CNC MACHINE TOOLS 9

Evolution of CNC Technology, principles, features, advantages, applications - CNC and DNC concept, systems - classification of CNC Machines turning center, machining center, grinding machine, EDM - Types of control CNC controllers, characteristics, interpolators - Computer Aided Inspection.

UNIT II STRUCTURE OF CNC MACHINE TOOL 9

CNC Machine building, structural details, configuration and design - Guide ways Friction - Anti friction and other types of guide ways - Elements used to convert the rotary motion to a linear motion Screw and nut, recirculating ball screw, planetary roller screw, rack and pinion - spindle assembly - torque transmission Elements gears, timing belts.

UNIT III DRIVES AND CONTROLS 9

Spindle drives - DC shunt motor, 3 phase - AC induction motor - Feed drives - Stepper motor - Servo principle - DC and AC servomotors - Open loop and closed loop control - Axis measuring system - synchro, synchro- resolver, gratings, moiré fringe gratings, encoders.

UNIT IV CNC PROGRAMMING 9

Coordinate system - Structure of a part program - G & M Codes - Tool length compensation - Cutter radius and tool nose radius compensation - Do loops, subroutines, canned cycles, mirror image, parametric programming - Machining cycles and programming for machining - Generation of CNC codes from CAM packages.

UNIT V TOOLING AND WORK HOLDING DEVICES 9

Introduction to cutting tool materials: Carbides, Ceramics, CBN, PCD inserts classification - PMK, NSH, holding qualified, semi qualified and preset tooling - Tooling system for machining center and turning center - Work Devices for rotating and fixed work parts - Economics of CNC - maintenance of CNC machines.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify the evolution, principles, classification and applications of CNC machine tools.
- define the basic structure, construction, working and control of CNC machines.
- identify the fundamentals of drive system and control modules of CNC technology.
- expand the program for CNC machines.
- propose the knowledge about different tooling and working holding devices of CNC.

TEXT BOOKS

1. P. Radhakrishnan, Computer Numerical Control Machine & Computer Aided Manufacturing, New Academic Science Limited.
2. Tilak Raj, CNC Technology & Programming, Dhanpat Rai publishing company(p) ltd., New Delhi.

REFERENCES

1. P. N. Rao and N. K. Tiwari, Numerical Control and Computer Aided Manufacturing, Tata McGraw-Hill Publishing company, New Delhi.
2. M. Adithan & B. S. Pabla, CNC Machines, New Age International Publishers , New Delhi.
3. HMT Limited, "Mechatronics", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.

WEB LINKS

1. http://www.brighthubengineering.com/manufacturing-technology
2. https://www.scribd.com/doc/29051586/Introduction-of-CNC-Machine

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

CH16501 ENVIRONMENTAL SCIENCE AND ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know the constituents of the environment and the precious resources in the environment.
- conserve all biological resources.
- understand the role of human being in maintaining a clean environment and useful environment for the future generations.
- acquire knowledge about ecological balance and preserve bio-diversity.
- understand the role of government and non-government organizations in environment management.

UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES 9

Environment: Definition - scope - importance - need for public awareness. Forest resources: Use - over exploitation - deforestation - case studies - mining - effects on forests and tribal people. Water resources: Use - over utilization of surface and ground water - floods - drought - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: world food problems - changes caused by agriculture and overgrazing - effects of modern agriculture- fertilizer -pesticide problems - water logging - salinity - case studies. Energy resources: Growing energy needs - renewable and non - renewable energy sources. Land resources: Land as resource - land degradation - soil erosion. Role of an individual in conservation of natural resources.

UNIT II ECOSYSTEMS AND BIODIVERSITY 9

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - energy flow in the ecosystem - ecological succession - food chains - food webs and ecological pyramids. Types of ecosystem: Introduction - characteristic features - forest ecosystem - grassland ecosystem - desert ecosystem - aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity: Introduction - definition (genetic - species -ecosystem) diversity. Value of biodiversity: Consumptive use - productive use - social values - ethical values - aesthetic values. Biodiversity level: Global - national - local levels - India as a mega diversity nation - hotspots of biodiversity. Threats to biodiversity: Habitat loss - poaching of wildlife - man wildlife conflicts - endangered and endemic species of India. Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity - field study.

UNIT III POLLUTION **9**

Pollution : Definition - air pollution - water pollution - soil pollution - marine pollution - noise pollution - thermal pollution - nuclear hazards. Solid waste management: Causes - effects - control measures of urban and industrial wastes. Role of an individual in prevention of pollution - pollution case studies. Disaster management: Floods - earthquake - cyclone - landslides. Electronic waste - sources - causes and its effects.

UNIT IV SOCIAL ISSUES AND ENVIRONMENT **9**

Sustainable development: Unsustainable to sustainable development - urban problems related to energy. Water conservation - rain water harvesting - watershed management. Resettlement and rehabilitation of people. Environmental ethics: Issues - possible solutions - climate change - global warming and its effects on flora and fauna - acid rain - ozone layer depletion - nuclear accidents - nuclear holocaust - wasteland reclamation - consumerism and waste products. Environment protection act: Air (Prevention and Control of Pollution) act -water (Prevention and control of Pollution) act - wildlife protection act - forest conservation act - issues involved in enforcement of environmental legislation.

UNIT V HUMAN POPULATION AND ENVIRONMENT **9**

Human population: Population growth - variation among nations - population explosion - family welfare programme and family planning - environment and human health - Human rights - value education - HIV/ AIDS, Swine flu - women and child welfare. Role of information technology in environment and human health.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the relationship between the human population and environment.
- elaborate the basic concepts of environment studies and natural resources.
- gain the knowledge about ecosystem and biodiversity.
- have knowledge about causes, effects and control measures of various types of pollution.
- understand the social issues and various environmental acts.

TEXT BOOKS

1. Raman Sivakumar, Introduction to Environmental Science and Engineering, 2nd Edn, Tata McGraw Hill Education Private Limited, New Delhi, (2010).
2. Benny Joseph, "Environmental Science and Engineering", Tata McGraw Hill, (2010).

REFERENCES

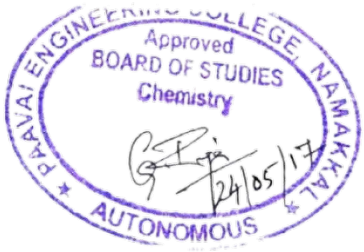
1. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad India,2010.
2. S. Divan, Environmental Law and Policy in India, Oxford University Press, New Delhi, 2001.
3. K.D. Wager, Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.
4. W.P. Cunningham, Environmental Encyclopaedia, Jaico Publishing House, Mumbai, 2004.

5. Clair Nathan Sawyer, Perry L. McCarty, Gene F. Parkin, “Chemistry for Environmental Engineering and Science”, McGraw-Hill Education; 5 edition, 2002.

WEB LINKS

1. www.chegg.com
2. www.vidhyarathiplus.com

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	-	-	2		-
CO2	-	-	2	-	-		-		-	2	-	2		2
CO3	2	-	2	-	2		-		-	2	-	2		-
CO4	2		2	-	2		3		-	2	-	2		2
CO5	-		-	-	-		3		2	2	-	2		-



EE16508 POWER ELECTRONICS LABORATORY 0 0 4 2

(Common to EEE & MCT)

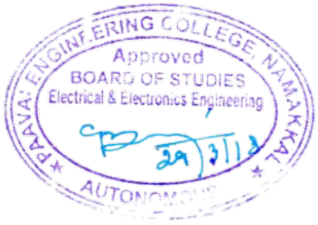
COURSE OBJECTIVES

To enable the students to

- study the characteristics of switching devices.
- study the applications of rectifiers.
- analyze performance of inverters and choppers.
- design 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

At the end of this 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.

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	-	-	3	-	-	-	-	-	3	-	3	-
CO2	3	3	-	-	3	-	-	-	-	-	3	-	3	-
CO3	3	3	-	-	3	-	-	-	-	-	3	-	3	-
CO4	3	3	-	-	3	-	-	-	-	-	3	-	3	-

MT16504 SENSORS AND INSTRUMENTATION LABORATORY 0 0 2 1

COURSE OBJECTIVES

To enable the students to

- develop the analysis and design skills needed in PC based acquisition and control systems.
- measure voltage, current, temperature, displacement, power and torque.
- provide hands on experience on measuring instruments.
- understand the concept of controlling the parameters based on measurement.

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 different signals.
- analyze the servomotor position control using photo electric pickup.
- create the appropriate design procedure to obtain a required measurement data.
- identify the signal processing techniques to convert them to usefulsignal.

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		1		3	2	1	-	2	3
CO2	3	-	-	-	-		1		3	2	1	-	-	2
CO3	3	-	2	-	3		-		3	-	1	-	2	1
CO4	2	-	1	-	1		1		3	3	2	-	2	2

MT16505 CNC PROGRAMMING LABORATORY 0 0 2 1

COURSE OBJECTIVES

To enable the students to

- design problems in a systematic manner.
- instruct the manual and computer assisted part programming, tool path generation operation and control of CNC machines tools.
- use the CNC machines efficiently for manufacturing desired products and knowledge of programming and use of CNC tooling.
- implement CNC programs for milling and turning machining operations.

LIST OF EXPERIMENTS

1. Study of G codes and M codes for machining center and turning center.
2. Manual part programming using G and M codes for Turning, step turning, Taper turning, thread cutting and radius turning on cylindrical components.
3. Given a component drawing to write the manual part programming and execute on CNC Lathe and Milling Machine.
4. Programming and Simulation of machining using the following features.
   (i) Linear and Circular interpolation.
   (ii) Pocket milling, slotting, peck drilling and other fixed canned cycles.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- program in the CNC machines to generate any contour/profile.
- use an understanding of General and Machine (G & M) code to generate or edit a program which will operate a CNC Lathe.
- develop the CNC program for machining center.
- develop the CNC program for pocket milling, slotting, peck drilling and other fixed canned cycles.

REFERENCES

1. T. William W. Lugges, CNC A First Look Primer, Delmar Publishers, New York, (1997).
2. Alan Overby, CNC Machining Handbooks: Building, Programming and Implementation, McGraw-Hill Publishing Company Ltd, New York, (2011).

WEB LINKS

1. http://www.sosmath.com/matrix/matrix.html

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	2	-	1	-	-	-	-	-	-	-	-	2	1
CO2	1	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	2	-	3	-	-	-	-	-	-	-	-	1	1
CO4	-	2	-	-	-	-	-	-	-	-	-	-	1	-

EN16501 CAREER DEVELOPMENT LABORATORY I 0 0 2 1

COURSE OBJECTIVES

To enable the students to

- to understand their capabilities and enhance their grooming and showcasing his/her capabilities to a prospective employer.
- to provide opportunity for the students to become acquainted with corporate opportunities relevant to their academic learning.
- to articulate their thoughts on a given topic - in English and also to make decent write ups in English on any given topic.
- to practice and score well in Aptitude tests conducted by corporate / prospective employers.
- to prepare for any group discussion evaluation or presenting their credentials during a face -to-face interview leading to selection and employment.
- to become a knowledgeable person on the various evaluation processes leading to employment.

UNIT I BASICS - SELF ANALYSIS 6

Introduction - Self Explorations: Who Am I, Personal Attributes, Self Confidence and Self Esteem - Communication Skills : Introduction to communication, Flow of communication, Listening, Barriers of communications, How to overcome the barriers of communications - Leadership Qualities : Skills for a good Leader, Leadership styles, SWOT Analysis, - Time Management: Time is a resource, Identify Time wasters, Time Management Styles, Techniques for better time management - Group Dynamics/ Team Building: Importance of group in organizations, Team Building, Interaction with the team, How to build the good team.

UNIT II PERSONALITY DEVELOPMENT 6

Motivation: Introduction, Relevance and types of motivation, Analysis of motivation - Attitude : Factors, Influencing Attitude, Challenges and lessons from attitude - Creativity : Out of box thinking, Lateral thinking - Goal Setting : Wish list ; Blue print for success; Short, long, life time goals.

UNIT III QUANTITATIVE APTITUDE 6

Number System - LCM & HCF - Square root & Cube root - Percentage - Time speed & Distance.

UNIT IV QUANTITATIVE APTITUDE 6

Trains - Boats & Streams - Average - Ages - Area.

UNIT V LOGICAL AND VERBAL REASONING 6

Series Completion : Number Series, Letter series, Symbol Series - Blood Relation - Coding and decoding - Logical Sequence - Analogy - Character Puzzles - Classification - Data sufficiency.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- demonstrate aptitude and reasoning skills.
- enhance verbal and written ability.
- improve his/her grooming and presentation skills.
- interact effectively on any recent event / happenings / current affairs.
- be a knowledgeable person on the various evaluation processes leading to employment and face the same with confidence.

REFERENCE BOOKS

1. Agarwal, R.S." a modern approach to Verbal & Non Verbal Reasoning", S. Chand & Co Ltd, New Delhi.
2. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill.
3. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.
4. Johnson, D.W. Reaching out - Interpersonal Effectiveness and self-actualization Boston: Allyn and Bacon.
5. Agarwal, R.S. "Objective General English", S. Chand & Co.
6. Infosys Campus Connect Program - students' guide for soft skills.

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	-	-	-	-	-	3	3	3	2	2	2
CO2	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO3	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO4	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO5	3	-	2	-	-	-	-	-	3	3	3	2	2	2

EVALUATION

PAPER I - CAREER DEVELOPMENT LAB 1:

S.NO	**PARTICULAR**	**TEST PORTION**	**MARKS**
1.	Evaluation 1 : Oral Communication	Group Discussion & Role Play	20
2.	Evaluation 2: Presentation	Mock Interview	20
3.	Evaluation 3: Written Test	60 Questions: (20 Each from unit 3,4 & 5)	60
TOTAL			100

SEMESTER VI

BA16151 PROFESSIONAL ETHICS AND HUMAN VALUES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the basic human values for a professional.
- discuss the significance of ethics in engineering and the theories related to it.
- familiarize oneself with the role of engineer as responsible experimenters.
- expose the students to their roles and responsibilities in assessing safety and reducing risks.
- describe the global issues in ethics and role of engineers as manager and consultants.

UNIT I HUMAN VALUES 9

Morals, Values and Ethics - Integrity - Work Ethic - Service Learning - Civic Virtue - Respect for Others -Living Peacefully - caring - Sharing - Honesty - Courage - Valuing Time - Cooperation - Commitment -Empathy - Self-Confidence - Character - Spirituality.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' - variety of moral issues - types of inquiry - moral dilemmas- moral autonomy- Kohlberg's theory - Gilligan's theory - consensus and controversy - Models of Professional Roles - theories about right action - self-interest - customs and religion - uses of ethical theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger case study.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the Three Mile Island and Chernobyl case studies. Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination.

UNIT V GLOBAL ISSUES 9

Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers-consulting engineers - engineers as expert witnesses and advisors - moral leadership - sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE), India, etc.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- describe the basic human values for a professionals.
- understand the significance of ethics in engineering and the theories related to it.
- be familiar with the role of engineer as responsible experimenters.
- acquire knowledgeabout their roles and responsibilities in assessing safety and reducing risks.
- discuss the global issues in ethics and role of engineers as manager and consultants.

TEXT BOOKS

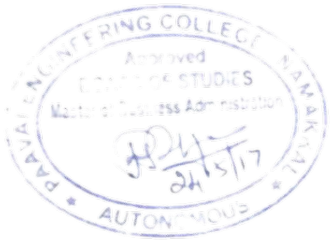
1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York (2005).
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics -Concepts and Cases", Thompson Learning, (2000).

REFERENCES

1. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, (1999).
2. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, (2003).
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, (2001).
4. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics - An Indian Perspective",Biztantra, New Delhi, (2004).
5. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003).

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



MT16601 PLC AND AUTOMATION 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- provide a clear view on Programmable Logic Controllers (PLC).
- propose the various methods involved in automatic control and monitoring.
- develop the PLC program for various applications.
- familiarize with the communication protocols.
- learn the use of Supervisory Control and Data Acquisition (SCADA).

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 and retentive Timers; UP counter, DOWN Counter and 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 and process control application.

UNIT IV PLC MAINTENANCE AND CASE STUDIES 9

PLC maintenance - internal PLC faults - faults external to PLC - watch dogs - safety; Hardware safety circuits - troubleshooting; Case Studies: PLC as robot controller and FMS - PLC to factory automation

UNIT V INTRODUCTION TO SCADA AND DCS 9

Supervisory Control and Data Acquisition Systems: Introduction - Evolution of SCADA - features of SCADA - SCADA Architecture - Components of SCADA - Master Terminal Unit - Remote terminal Unit - SCADA Communications; Distributed Control System**:** Evolution - Architectures - Local control unit - Process interfacing issues - Communication facilities

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.
- know about the maintenance of PLC.
- realize the use of Supervisory Control and Data Acquisition

TEXT BOOKS

1. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing (P) Ltd., New Delhi, 2017.
2. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, (4e), ISA Publication, 2009.

REFERENCES

1. Lukcas M.P., “Distributed Control Systems”, Van Nostrand Reinhold Co., New York, 1986.
2. Bolton , "Programmable Logic Controllers 5th Edition Newnes,2009.

WEB LINKS

1. http://electrical;engineering;portal.com/basic;steps;in;plc;programming
2. www.control.com
3. www.automation;info.com

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

MT16602 HYDRAULICS AND PNEUMATICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- identify the concepts of fluid power.
- examine the fundamental knowledge of hydraulic and pneumatic system.
- design and operation of hydraulic and pneumatic components and systems.
- use application in manufacturing and mechanical systems.
- identify the design of hydraulic and pneumatic circuits applied in industries.

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 - 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: Cylinders - Types and 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, Design of pneumatic Circuit cascade method - Electro pneumatic circuits. Accumulators: types and applications.

UNIT V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic Systems - Case studies and Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift Applications. Design of Pneumatic circuits for a Pick and Place application - Case studies.

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.
- construct the fluid power circuits applied in industries.

TEXT BOOKS

1. Anthony Esposito, “Fluid Power with Applications”, Pearson, (2009).
2. S. R. Majumdar, “Pneumatic systems - Principles and maintenance”, Tata McGraw Hill, (2014).

REFERENCES

1. James L. Johnson, “Introduction to Fluid Power”, Delmar Thomson Learning, (2013).
2. Andrew Parr, “Hydraulics and Pneumatics”, Jaico Publishing House, (2015).
3. Illangov Soundarrajan, “Introduction to Hydraulics and Pneumatics, Prentice hall of India, New Delhi, (2015).
4. S. R. Majumdar, “Oil Hydraulics”, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, (2014).
5. Pinches, “Industrial Fluid Power”, Prentice hall, New Delhi, (2008).

WEB LINKS

1. http://www.jmpeng.com/wp-content/uploads/2014/03/PickFlex-CaseStudy.pdf
2. http://www.arozone.com/en/products/diaphragm-pumps.html
3. http://hydraulicspneumatics.com/datasheet/bluetooth-and-smartphones-configure-hard-reach-hydraulic- valves-pdf-download

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	2
CO5	2	-	-	-	3	1	3	2	2	2	2	2	1	-

MT16603 THERMODYNAMICS AND HEAT TRANSFER 3 2 0 4
(Approved Heat and Mass Transfer Data Book is Allowed)

COURSE OBJECTIVES

To enable the students to

- access the knowledge on laws of thermodynamics concepts, principles and mechanism for physical systems.
- identify the applications of air standard cycles.
- solve one dimensional conduction heat transfer problems.
- apply empirical correlations for both forced and free convection to determine values for the convection heat transfer coefficient.
- understand the basic concepts of radiation heat transfer to include both black body radiation and gray body radiation.

UNIT I LAWS OF THERMODYNAMICS 15

Systems - closed and open systems - properties, processes and cycles - equilibrium - work and heat transfers - first law for a closed system and flow processes - enthalpy - second law - entropy - entropy change.

UNIT II AIR STANDARD CYCLES 15

Air standard cycles: Carnot cycle - Otto cycle - Diesel cycle - Brayton cycle - Rankine cycle - cycle efficiency - IC Engine: two stroke and four stroke engines.

UNIT III HEAT TRANSFER: CONDUCTION 15

Basic Concepts - Mechanism of Heat Transfer - Conduction, Convection and Radiation - Fourier Law of Conduction - General Differential equation of Heat Conduction - Cartesian and Cylindrical Coordinates - One Dimensional Steady State Heat Conduction.

UNIT IV CONVECTION 15

Convection: Basic Concepts - Heat Transfer Coefficients - Boundary Layer Concept - Types of Convection - Forced Convection - External Flow and Internal Flow - Flow over Plates, Cylinders and Spheres.

UNIT V RADIATION 15

Basic Concepts, Laws of Radiation - Stefan Boltzmann Law, Kirchhoff's Law - Black Body Radiation and Radiation Between different surfaces.

TOTAL PERIODS 75

COURSE OUTCOMES

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

- examine the laws and basic concept of thermodynamics.
- draw PV diagram and obtain the performance of air standard cycles.
- examine the one dimensional heat transfer through conduction for a given system.
- explain the types of convection and determine heat transfer coefficient.
- justify the radiation effect among different surfaces.

TEXT BOOKS

1. P. K. Nag, Engineering Thermodynamics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
2. C. P. Kothandaraman , Fundamentals of Heat and Mass Transfer, 3rd edition, New Age International publishers, New Delhi, 2006.

REFERENCES

1. Yunus A. Cengel and Michael A. Boles, Thermodynamics - An Engineering Approach in SI McGraw Hill Publishing Company, New Delhi, 2010.
2. T. D. Eastop and McConkey, Applied Thermodynamics for Engineering Technologists, 2004.
3. C. P. Kothandaraman and S. Subramanya, 8th Edition Heat and Mass Transfer Data Book, New International publishers, New Delhi, 2014.

WEB LINKS

1. https://www.grc.nasa.gov/www/BGH/heat.html
2. www.cdeep.iitb.ac.in/.../Heat%20and%20Mass%20Transfer/Conduction/.../1.2.html
3. nptel.ac.in/courses/112108149/pdf/M1/Student_Slides_M1.pdf

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

IT16305 OBJECT ORIENTED PROGRAMMING WITH C++ 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- learn the basic concepts of Object Oriented Programming.
- learn the basics of C++ language.
- know about C++ data types, access modifiers, classes and objects.
- work on identifying the relationship between classes.
- know about master of Object Oriented Programming using C++.

UNIT I INTRODUCTION TO C++ **9**

Object oriented programming concepts - Introduction to C++ - Tokens - Keywords - Identifiers and constants- Basic data types- User defined data types - Derived data types - Symbolic constants - Declaration of variables - Dynamic initialization of variables - Reference variables - Operators in C++ - Scope resolution operator - Manipulators - Expressions and their types - Control structures - The main function - Function prototyping - Call by reference - Return by reference - Inline functions - Default arguments - Function overloading.

UNIT II CLASSES AND OBJECTS **9**

Specifying a class - Defining member functions - Private member functions -Arrays within a class - Memory allocation for objects - Static data members - Static member functions - Arrays of objects - Objects as function arguments -Friendly functions - Returning objects. Constructors: Parameterized constructors - Multiple constructors in a class - Constructors with default arguments - Dynamic initialization of objects - Copy constructor - Dynamic constructors - Destructors.

UNIT III OPERATOR OVERLOADING AND INHERITANCE **9**

Defining operator overloading: Overloading unary, binary operators. Manipulation of strings using operators - Rules for overloading operators - Type Conversions - Defining derived classes - Single inheritance - Multilevel Inheritance - Multiple inheritance -Hierarchical inheritance - Hybrid inheritance - Virtual base classes - Abstract classes.

UNIT IV POLYMORPHISM AND TEMPLATES **9**

Introduction to pointers to objects: This pointer - Pointers to derived classes - Virtual functions - Pure virtual functions. Function templates, user defined template arguments, class templates.

UNIT V EXCEPTION HANDING AND GENERIC PROGRAMMING **9**

Exception Handling: Exception handling mechanism, multiple catch, nested try, rethrowing the exception - Namespaces - std namespace- Standard Template Library.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify and apply object oriented concepts like abstraction, encapsulation, modularity, hierarchy, typing, concurrency and persistence.
- relate real world object into entity.
- create reusable system components.
- estimate various metrics specific to object oriented development.
- predict runtime error using exception handling technology.

TEXT BOOKS

1. E.Balagurusamy, "Object Oriented Programming with C++", Tata McGraw Hill, Sixth Edition, 2013.

REFERENCES

1. Ira Pohl, "Object Oriented Programming using C++", Pearson Education, Second Edition.
2. S. B. Lippman, JoseeLajoie, Barbara E. Moo, "C++ Primer", Fourth Edition, Pearson.
3. B. Stroustrup, "The C++ Programming language", Third edition, Pearson Education, 2004.

WEB LINKS

1. http://nptel.ac.in/courses/106105151/
2. https://www.tutorialspoint.com/cplusplus/cpp-object-oriented.htm
3. http://www.studytonight.com/cpp/cpp-and-oops-concepts.php

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

MT16604 **PLC AND AUTOMATION LABORATORY** **0 0 2 1**

COURSE OBJECTIVES

To enable the students to

- provide a clear view on Programmable Logic Controllers (PLC).
- facilitate knowledge on PLC control principles and applications with field devices.
- train the students to create ladder diagrams for automatic control and monitoring.
- impart knowledge on configure 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 the 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

- understand the use of software in PLC.
- develop the PLC program for various applications like bottle filling, cylinder actuation and control.
- implement traffic control using PLC.
- compose the microcontroller interface.

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	-	-	-	-	1	-	2	-	-	2
CO2	3	-	-	2	-	-	2	-	1	1	2	-	-	1
CO3	3	-	-	1	-	-	-	-	1	-	-	-	-	2
CO4	3	3	-	-	-	-	3	-	-	-	2	-	-	2

IT16307 **OBJECT ORIENTED PROGRAMMING WITH C++ LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable the students to

- know fundamental knowledge of object oriented programming.
- demonstrate C++ syntax and semantics.
- solve simple engineering problems.
- know the development of solution for complex problems in the real world.

LIST OF EXPERIMENTS

1. Write C++ Programs using Classes and Objects.
2. Design C++ Classes with static members, methods with default arguments, friend functions.
3. Develop C++ Programs using Operator Overloading.
4. Develop C++ Programs using constructor, destructor, and copy constructor.
5. Develop C++ Programs Overload the new and delete operators.
6. Develop C++ Programs using Inheritance, Polymorphism and its types.
7. Develop C++ Programs using Arrays and Pointers.
8. Develop C++ Programs using Dynamic memory allocation.
9. Develop C++ Programs using Function Templates.
10. Develop C++ Programs using Exceptions Handling.
11. Write C++ Programs using Classes and Objects.
12. Design C++ Classes with static members, methods with default arguments, friend functions.

TOTAL PERIODS 60

COURSE OUTCOMES

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

- understand object-oriented concepts and how they are supported by C++.
- demonstrate the ability to analyze, use, and create functions, classes, to overload operators.
- create and initialize real world entities using constructors.
- apply the concepts of data encapsulation, inheritance, and polymorphism to develop large scale software.

RECOMMENDED SYSTEM/SOFTWARE REQUIREMENTS

Software: Turbo C++.

Hardware: Flavor of any WINDOWS or LINUX and Standalone desktops 30 Nos.

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	-	2	-	1	-	2	-	1	-	-	-
CO2	-		-		-		-	-	-		-	-	2	-
CO3	-	-	-	-	2	-	2	-	-	-	-	-	2	-
CO4	1	-	3	-	-	-	1	-	-	-	-	-	-	-

MT16605 **HYDRAULICS AND PNEUMATICS CONTROL LABORATORY** **0 0 2 1**

COURSE OBJECTIVES

To enable the students to

- understand the role of pneumatic and hydraulic systems in a complex mechatronics system.
- analyze pneumatic and hydraulic circuits, and identify basic components.
- invent and provide hand on experience to students to design and test hydraulic circuit to control press.
- design and test hydraulic, pneumatic circuits to perform basic operations.

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 simulation software.
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.

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.

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	-	-	2	-	-	-	3	-	3	-	1	-
CO2	1	2	-	-	2	-	-	3	3	-	2	-	1	1
CO3	2	2	-	-	1	-	-	1	-		2	-	-	2
CO4	1	2	-	-	3	-	-	-	3		2	-	1	3

EN16601 CAREER DEVELOPMENT LABORATORY II 0 0 2 1

COURSE OBJECTIVES

To enable the students to

- to understand their capabilities and enhance their grooming and showcasing his/her capabilities to a prospective employer.
- to provide opportunity for the students to become acquainted with corporate opportunities relevant to their academic learning.
- to articulate their thoughts on a given topic - in English and also to make decent write ups in English on any given topic.
- to practice and score well in Aptitude tests conducted by corporate / prospective employers.
- to prepare for any group discussion evaluation or presenting their credentials during a face -to-face interview leading to selection and employment.
- to become a knowledgeable person on the various evaluation processes leading to employment.

UNIT I CORPORATE READINESS 6

Business communication - Email, Paragraph, Letter Writing Skills - Public speaking skills: Rules of Public speaking skills; Extempore, JAM - Inter and intra personal skills: Introduction; Need for Inter and Intra personal skills in organizations - Stress management: Causes of stress and its impact, how to manage and distress, Circle of control, stress busters - Emotional Intelligence: What is emotional Intelligence, Why Emotional Intelligence Matters, Managing Emotions.

UNIT II INTERVIEW SKILLS 6

Interview Basics : General Selection process, Grooming, Dress code, Supporting Documents to carry - Resume Building : Impact of Powerful CV, Do's and don'ts in CV - Group Discussion : Introduction to GD, Important of Listening and Speaking skills, Do's and Don't in GD - Face to face interview / Hire me: Rules for face to face interview, body language, Self-Introduction - Psychometric Assessment : Importance of Psychometric assessment, Why psychometric assessment.

UNIT III QUANTITATIVE APTITUDE 6

Simplification - Time and work - Pipes and cisterns - Ratio and Proportion - Partnership.

UNIT IV QUANTITATIVE APTITUDE 6

Simple interest and Compound interest - Profit and loss - Permutation and combination Probability - Calendar

UNIT V LOGICAL AND VERBAL REASONING 6

Seating arrangement - Direction - Arithmetic reasoning - Syllogisms - Making Judgments - Statements and conclusions - Matching definition - Cause and effect.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- demonstrate aptitude and reasoning skills.
- enhance verbal and written ability.
- improve his/her grooming and presentation skills.
- interact effectively on any recent event / happenings / current affairs.
- be a knowledgeable person on the various evaluation processes leading to employment and face the same with confidence.

REFERENCE BOOKS

1. Agarwal, R.S. "A modern approach to Verbal & Non Verbal Reasoning", S. Chand & Co Ltd, New Delhi.
2. Abhijit Guha, "Quantitative Aptitude", Tata-McGraw Hill.
3. Word Power Made Easy by Norman Lewis, Wr. Goyal Publications.
4. Johnson, D.W. Reaching out - Interpersonal Effectiveness and self-actualization. Boston: Allyn and Bacon.
5. Agarwal, R.S. "Objective General English", S. Chand &Co.
6. Infosys Campus Connect Program - students' guide for soft skills.
7. Mitra, Barun.k, "Personality Development & Soft skills", Oxford University.

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	-	-	-	-	-	3	3	3	2	2	2
CO2	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO3	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO4	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO5	3	-	2	-	-	-	-	-	3	3	3	2	2	2

EVALUATION

PAPER II - CAREER DEVELOPMENT LAB 2

S.NO	PARTICULAR	TEST PORTION	MARKS
1.	Evaluation 1 : Oral Communication	Group Discussion & Role Play	20
2.	Evaluation 2: Presentation	Mock Interview	20
3.	Evaluation 3: Written Test	60 Questions: (20 Each from unit 3,4 & 5)	60
TOTAL			100

PROGRAMME ELECTIVE COURSES (PE)

PROGRAMME ELECTIVE - I

MT16151 ADVANCED MANUFACTURING PROCESSES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- identify the several non-traditional machining process in micro and precision manufacturing field.
- select the suitable electro chemical machining process for materials considering their merits and demerits.
- study the various process parameters and their effect on the component machined on various thermo electrical machining processes.
- build broad understanding of laser based physical processes and their implications in material processing and manufacturing processes.
- provide the students with an understanding of the basic fundamentals of rapid prototyping, its fabrication techniques, materials and various areas of defects and improvements in Rapid Prototyping.

UNIT I ADVANCED 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 ELECTRO CHEMICAL MACHINING 9

Electro chemical machining - Chemical material removal - Types - Electro chemical machining (ECM) - Electro chemical drilling (ECD) - Electro chemical grinding (ECG) - Electro chemical honing (ECH) - Shaped tube electrolytic machining - Operating principle - Process parameters - Applications - Limitations.

UNIT III THERMO ELECTRICAL MACHINING 9

Thermo electrical machining - Types - Electrical discharge machining (EDM) - Electrical discharge wire cutting (EDWC) - Electron beam machining (EBM) - Ion Beam Machining (IBM) - Plasma Arc Machining (PAM) - Operating principle - Process parameters - Applications - Limitations.

UNIT IV LASER MATERIALS PROCESSING 9

Laser materials processing - Laser types - Processes - Laser beam machining (LBM) - Laser cutting (LC) - Laser drilling (LD) - Laser marking and engraving (LM) - Laser micromachining (LMM) - Laser engineered net shaping (LENS) - Applications - Limitations.

UNIT V SPECIAL PROCESSING TECHNOLOGIES 9

Special processing technologies - Rapid Prototyping - Methods - Fused Deposition Modeling (FDM) - Laminated Object Manufacturing (LOM) - Selective laser sintering (SLA) - Solid Ground curing (SGC) - 3D printing (3DP) - Processing of integrated circuits - Micro and nano fabrication technologies.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify the contribution of non-traditional machining process in micro and precision.
- select the most appropriate process for a given product design, application requirements and constraint.
- summarize the merits and demerits of the non-traditional manufacturing process.
- to identify, select, and optimize laser materials processes through case studies of practical problems and probable solutions for innovative and potential next generation manufacturing.
- invent subtractive and additive (3D-Printing) manufacturing for rapid prototyping.

TEXT BOOKS

1. Abdel, H. and El-Hofy, G. “Advanced Machining Processes”, McGraw-Hill, USA, 2005.
2. Wellar, E.J. "Non-Traditional Machining Processes", Society of Manufacturing Engineers Publications, 2nd edition, Michigan, 1984.

REFERENCES

1. Steen, W.M. and Watkins, K. “Laser Materials Processing”, Springer London Ltd, 2003.
2. Groover, M.P. “Fundamentals of modern manufacturing processes - Materials, Processes and Systems.

WEB LINKS

1. nptel.ac.in/courses/112107077/
2. https://www.iitk.ac.in/me/advanced-manufacturing-processes
3. https://www.nhti.edu/.../course.../advanced-manufacturing-processes-course-descriptio.

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

MT16152 DIGITAL SIGNAL PROCESSING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- introduce discrete fourier transform and its applications.
- list signal processing concepts in systems having more than one sampling frequency.
- define structure and techniques of IIR filter.
- define structure and techniques of FIR filter.
- teach the design of infinite and finite impulse response filters for filtering undesiredsignals.

UNIT I SIGNALS AND SYSTEMS 9

Basic elements of DSP - concepts of frequency in Analog and Digital Signals - sampling theorem - discrete - time signals, systems - analysis of discrete time LTI systems - Z transform - convolution - correlation.

UNIT II FREQUENCY TRANSFORMATIONS 9

Introduction to DFT - properties of DFT - circular convolution - filtering methods based on DFT - FFT algorithms - decimation - in - time algorithms, Decimation - in - frequency algorithms - Use of FFT in linear filtering - DCT - use and application of DCT.

UNIT III IIR FILTER DESIGN 9

Structures of IIR - analog filter design - discrete time IIR filter from analog filter - IIR filter design by impulse invariance, Bilinear transformation, Approximation of derivatives - (LPF, HPF, BPF,BRF) filter design using frequency translation.

UNIT IV FIR FILTER DESIGN 9

Structures of FIR - linear phase FIR filter - fourier series - Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanging Window), Frequency sampling techniques.

UNIT V FINITE WORD LENGTH EFFECTS IN DIGITAL FILTERS 9

Binary fixed point and floating point number representations - comparison - quantization noise - truncation and rounding - quantization noise power - input quantization error - coefficient quantization error - limit cycle oscillations - dead band - overflow error - signal scaling.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- know the discrete Fourier transform and its applications.
- perform frequency transforms for the signals.
- design IIR filters.
- design FIR filters.
- construct finite word length effects in digital filters.

TEXT BOOKS

1. John G. Proakis and Dimitris G.Manolakis, “Digital Signal Processing - Principles, Algorithms & applications”, Fourth Edition, Pearson Education, Prentice Hall, (2015).

REFERENCES

1. Emmanuel C.Ifeachor, and Barrie.W.Jervis, “Digital Signal Processing”, Second Edition, Pearson Education, Prentice Hall, (2012).
2. Sanjit K. Mitra, “Digital Signal Processing - A Computer Based Approach”, Third Edition, Tata McGraw Hill, (2012).
3. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 8th Indian Reprint, Pearson, (2014).
4. Andreas Antoniou, “Digital Signal Processing”, Tata McGraw Hill, (2015).

WEB LINKS

1. http://www. signals and systems .html
2. http://www. filter design.html
3. http://www.digital filters.html
4. http://www. signal Processing.html

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

MT16153 DIAGNOSTIC TECHNIQUES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- identify with various types of maintenance, their procedure and defects analysis commonly adopted in manufacturing industries.
- discriminate preventive, predictive and failure maintenance.
- describe procedures and guidelines on work permit system to carry out jobs of inspection, testing, maintenance, alternation, repair, upkeepment and construction in safest possible manner.
- distinguish about usage of computers for maintenance management.
- understand how condition monitoring techniques can be used to detect and analyse some common machinery problems.

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.

UNIT II MAINTENANCE SYSTEMS 9

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 and operating manual - maintenance manual and departmental manual - maintenance time standard - maintenance work order and work permit - job monitoring - feedback and control - 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 - captive engineering module. Decision making in maintenance. Economic aspects of maintenance.

UNIT V CONDITION MONITORING 9

Condition monitoring techniques - visual monitoring -temperature monitoring - vibration monitoring - lubricant monitoring - cracks monitoring - thickness monitoring - noise and sound monitoring - 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

- classify the maintenance system and select suitable one based on requirement.
- identify the documentation and record updating involved in maintenance systems.
- prepare the maintenance plan and explain the cost benefit analysis.
- analyze the defects and failures encountered in manufacturing system.
- establish the monitoring strategies according to system characteristics.

TEXT BOOKS

1. Keith Mobley, Lindley Higgins and Darrin Wikoff, "Maintenance Engineering Handbook", McGraw-Hill, 2008.
2. Sushil Kumar Srivastava, Industrial Maintenance Management, S. Chand and Company Ltd, New Delhi, 2006.

REFERENCES

1. Manfred, H. "Bibring, Handbook of Machine Tools", Vol.3, John Wiley & Sons.
2. Mishra R.C., Pathak K. "Maintenance Engineering and Management", Prentice Hall of India Private Ltd., New Delhi, 2002.
3. R. Keith Mobley, Maintenance Fundamentals, Butterworth Heinemann Publications, USA, 2004.

WEB LINKS

1. https://www.lce.com/Whats-the-role-of-the-Reliability-Engineer-1227.html
2. http://www. defects and failure analysis.html
3. https://www.hon.ch/HONselect/Selection/E01.370.html

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

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

MT16154 MODELLING AND SIMULATION IN ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- define the basics of simulation modeling and replicating the practical situations in organizations.
- generate random numbers and random variates using different techniques.
- develop simulation model using heuristic methods.
- analysis of simulation models using input analyzer, and output analyzer.
- get elaborate knowledge on system identification and decision making.

UNIT I SYSTEM AND SYSTEM ENVIRONMENT 9

Component of a system - continuous and discrete systems - types of model; Steps in simulation study; Simulation of an event occurrence using random number table - single server queue -two server queues - inventory system.

UNIT II RANDOM NUMBER GENERATION 9

Properties of random numbers - generation of pseudo - random numbers - techniques of generating pseudo random numbers; test for random numbers: the chi-square test-the Kolmogorov smirnov test - runs test - gap test - poker test.

UNIT III RANDOM - VARIATE GENERATION 9

Inverse transform technique for exponential, uniform, triangular, weibull, empirical, uniform and discrete distribution, acceptance rejection method for poisson and gamma distribution; direct transformation for normal distribution.

UNIT IV ANALYSIS OF DATA 9

Analysis of simulated data - data collection, identifying the distribution, parameter estimation, goodness of fit tests, verification and validation of simulation models.

UNIT V SYSTEM IDENTIFICATION 9

Concepts of system identification - identification using normal operating records (integration method) - identifiability conditions - system order determination.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- describe the simulation and its importance in creation of models for real time systems.
- describe the different types of systems.
- simulate the real time systems by generating the random numbers and variables.
- design and analyze the model using simulation software packages.
- identify system using integration method.

TEXT BOOKS

1. Banks J., Carson J.S. and Nelson B.L., “Discrete - Event System Simulation”, 3rd Edition, Pearson Education, Inc 2004 (ISBN 81-7808-505-4).

REFERENCES

1. Geoffrey Gorden, “System Simulation”, Prentice Hall of India, 2003.
2. Narsingh Deo., “System Simulation with Digital Computer”, Prentice Hall of India, 2003.
3. Birta, "Modelling and Simulation: Exploring Dynamic System Behaviour", Springer, Indian Reprint, 2010.

WEB LINKS

1. https://web.stanford.edu/class/archive/ee/ee392m/ee392m.../Lecture9_ModelSim.pdf
2. https://computational-eng.llnl.gov/
3. aimday.se/modelling-simulation/modelling-simulation/

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

MT16155 PRODUCT DESIGN AND COSTING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- identify the several aspects of the design process.
- study the concept of product costing, patenting and manufacturing economics in product design.
- identify with the relationship between customer desires.
- propose the functional requirements, product materials and product design.
- investigate 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 and Stephen D. Eppinger, "Product Design and Development", McGraw- Hill Book Company, New Delhi, (2009).
2. Benjamin W. Niebeland Alanb.Draper, "Product Design and Process Engineering", Tata Publishing Company Ltd, New Delhi, (1976).

REFERENCES

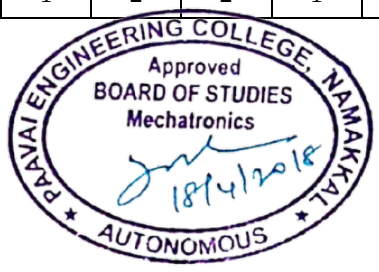
1. George E. Dieter, "Engineering Design - Materials and Process Approach", Tata McGraw- Hill Publishing Company Limited, New Delhi, (2008).
2. S. Dalela and MansoorAli, "Industrial Engineering and Management Systems", Standard Publishers Distributors Pvt. Ltd., New Delhi, (2006).
3. Harry Nystrom,"Creativity and Innovation", John Wiley and Sons Pvt. Ltd., Singapore, McGraw-Hill, (1988).
4. S. B. Srivastava, "Industrial Management",I. K. International Publishing House Pvt. Ltd., New Delhi, (2012).

WEB LINKS

1. https://help.sap.com/doc/.../3.6/en-US/1c9acf535b804808e10000000a174cb4.html
2. https://www.diva-portal.org/smash/get/diva2:621113/FULLTEXT01.pdf
3. productdesignmanagement.com/design-to-cost/

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

	Programme Outcomes (POs)													
COs	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



OPEN ELECTIVES (OE)

MT16901 INDUSTRIAL ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- identify the use of forecasting, control of inventory, process of routing and scheduling for improving productivity.
- construct and solve linear programming problem.
- investigate deterministic and probabilistic models of problems related to networks and queuing.
- understand the concepts of linear programming technique.
- know decision theory and game theory techniques.

UNIT I PRODUCTION PLANNING AND CONTROL 9

Productivity - productivity index - productivity measurement - job design - job standard - work study - method - study - operation process chart - motion study - motion economy - SIMO chart - work measurement - PMTS ergonomics; Industrial safety - losses due to accidents, causes, preventive measures; Forecasting - types - accuracy of forecast - sales forecasting techniques; Time series method - simple moving average, weighted moving average, exponential smoothing.

UNIT II INVENTORY CONTROL 9

Inventory control - purpose - inventory costs - EOQ - deterministic models - shortage model; Classification - ABC analysis, FSN analysis; Material Requirement Planning (MRP).

UNIT III SCHEDULING AND QUEUING 9

Introduction - rules - factors affecting - master schedule - Gantt chart; Sequencing problem - models with n jobs with 2 machines, models with n jobs with 3 machines; Queuing models - basic queuing systems and models - notation - parameter - poisson arrival - exponential service - constant rate service - infinite population.

UNIT IV LINEAR PROGRAMMING 9

Introduction - formulation - graphical method, simplex method artificial variable techniques: Big M and Two phase method; Transportation Problems - North West corner method, least cost method, Vogel's approximation Method - MODI method - assignment problems with Hungarian algorithm.

UNIT V NETWORK MODELS 9

Network models - shortest route - minimal spanning tree - maximum flow models - project network - CPM and PERT networks - critical path scheduling.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the ways of improving productivity by job design, work study, ergonomics, forecasting techniques and following safety.
- explain the inventory control techniques and the need for material requirement planning.
- solve the sequencing of 'n' jobs with two and more machines and also compute the characteristics of single server queuing models.
- formulate the linear programming problems and find the optimum solution.
- construct the network model and identify the critical path of deterministic and probabilistic models.

TEXT BOOKS

1. Prem Kumar Gupta and D. S. Hira, "Operations Research", S. Chand and Co., New Delhi, 2014.
2. S. B. Srivastava, "Industrial Management", I. K. International Publishing House Pvt. Ltd., New Delhi, 2012.
3. T. R. Banga, N. K. Agarwal and S. C. Sharma, "Industrial Engineering and Management Science", Khanna Publishers, Delhi.

REFERENCES

1. Hamdy A. Taha, "Operation Research: An introduction", Pearson Publications., New Delhi, (2010).
2. Frederick S. Hiller and Gerald J. Liberman, Operations Research: Concepts and cases, Tata McGraw-Hill Publishing Company Pvt Ltd., New Delhi, 2010.

WEB LINKS

1. http://www. industrial management.html
2. http://www.operation research.html
3. mime.oregonstate.edu/what-do-industrial-engineers-do

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

MT16902 **MECHATRONICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- familiarize about sensors and control system used in mechatronics.
- learn about the various fluid power system in mechatronics.
- understand and able to write PLC programming.
- get a precise idea about the system structural models and working of controllers.
- develop confidence and competence in designing mechatronics systems.

UNIT I SENSORS AND CONTROL DRIVES **9**

Introduction to mechatronics systems - measurement systems; Sensors and Transducers - performance terminology - Displacement measurement - Optical encoders; Flow measurement -Turbine meter; Liquid level using float; Piezoelectric sensors; Tactile sensor; Proximity switches; Smart sensors ; Selection of sensors; Control systems; Stepper motors; Servo motors.

UNIT II FLUID POWER SYSTEM IN MECHATRONICS **9**

Pneumatic and Hydraulic Systems; Electrical devices and switches; Solenoids; Electrically actuated directional control valves; Electro hydraulic servo valve and proportional control valve; Dual cylinder sequence circuit; Electrical control of regenerative circuit.

UNIT III INDUSTRIAL AUTOMATION **9**

Programmable Logic Controllers - basic structure - input and output field devices - principles of operation - relay logic control - timers - counter - simple PLC programming - selection of PLC; Introduction to Supervisory control and data acquisition; Distributed control system.

UNIT IV BASIC SYSTEM MODELS AND CONTROLLERS **9**

Building blocks of mechanical, electrical, fluid and thermal systems - rotational - translational systems - electromechanical systems; hydraulic - mechanical systems; Continuous and discrete process controllers; Control mode - proportional mode - derivative mode - integral mode - PID controllers; Digital controllers; Velocity control; Adaptive control.

UNIT V MECHATRONICS SYSTEMS **9**

Stages in design - traditional and mechatronics design, possible mechatronics design solutions; Case studies of mechatronics systems - pick and place robot - engine management system - automatic car park systems - washing machine system.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- design components and systems to integrate computers, sensors and transducers in mechanical system to meet desired needs.
- design electrically controlled fluid power circuits for various industrial applications.
- develop PLC ladder program for industrial automation and control.
- model different kinds of system and identify a suitable control.
- design a mechatronics system for a given application.

TEXT BOOKS

1. W. Bolton, Mechatronics: Electronic control systems in Mechanical and Electrical Engineering, Pearson Education, New Delhi, 6th Edition, 2015.
2. Nitaigour Premchand Mahalik, Mechatronics: Principles, Concepts and Applications, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2017.

REFERENCES

1. David G. Alciature and Michael B. Histand, Introduction to Mechatronics and Measurement Systems, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2007.
2. M. D. Singh, and J. G. Joshi, Mechatronics, Prentice Hall of India, New Delhi, 2009.
3. Rolf Isermann, "Mechatronic Systems Fundamentals", Springer, 2003.
4. Robert H Bishop, "Mechatronics: Introduction", Taylor and Franics, 2006.

WEB LINK

1. http://nptel.ac.in/courses/112103174/3
2. www.eng.um.edu.mt/dme/students/MFE3004AdditionalPT5
3. me.sabanciuniv.edu/en/research/research-areas/design-of-mechatronic-systems

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

MT16903 MICRO ELECTRO MECHANICAL SYSTEMS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- analyse the different materials used for MEMS.
- identify and understand the various sensors and actuators.
- understand the rudiments of microfabrication techniques.
- learn about the various micromachining process.
- gain knowledge about design considerations and various packaging technologies.

UNIT I INTRODUCTION TO MICROSYSTEMS 9

Overview of microelectronics manufacture and microsystems technology; Definition - MEMS materials; Laws of scaling; The multi-disciplinary nature of MEMS; Survey of materials central to micro engineering; Applications of MEMS in various industries.

UNIT II MICRO SENSORS AND ACTUATORS 9

Working principle of Microsystems - micro actuation techniques - micro sensors - types - Microactuators - types - micropump - micromotors - microvalves - microgrippers - microaccelerometers.

UNIT III FABRICATION PROCESS 9

Substrates - single crystal silicon wafer formation - Photolithography - Ion implantation - Diffusion - Oxidation - CVD - Physical vapor deposition - Deposition epitaxy - etching process.

UNIT IV MICROMACHINING 9

Silicon Anisotropic Etching - Anisotropic Wet Etching - Dry Etching of Silicon - Plasma Etching - Deep Reaction Ion Etching (DRIE) - Isotropic Wet Etching - Gas Phase Etchants - case studies; Basic surface micromachining processes - structural and sacrificial materials - acceleration of sacrificial Etch - striction and antistriction methods - LIGA Process; Assembly of 3D MEMS - Foundry process.

UNIT V MICROSYSTEMS DESIGN AND PACKAGING 9

Design considerations - Mechanical Design - process design - realization of MEMS components using intellisuite; Micro system packaging - packing technologies - assembly of microsystems - reliability in MEMS.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the applications of MEMS in various industries.
- evaluate the techniques used in micro sensors and actuators.
- design the micro devices, micro systems using the MEMS fabrication process.
- analyze the drawbacks in etchings and micromachining processes.
- create new designs on microsystems and packaging.

TEXT BOOKS

1. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.
2. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2006.

REFERENCES

1. Maluf, Nadim, "An introduction to Micro electro mechanical Systems Engineering", AR Tech house, Boston, 2000.
2. Mohamed Gad - el - Hak, "MEMS Handbook", CRC Press, 2002.
3. Julian W.Gardner, Vijay K.Varadan, Osama O. Awadel Karim, "Micro sensors MEMS and Smart Devices", John Wiby & sons Ltd., 2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.

WEB LINK

1. http://nptel.ac.in/courses/112101098/download/lecture-37.pdf
2. https://internetofthingsagenda.techtarget.com/definition/micro-electromechanical-systems-MEMS
3. https://compliantmechanisms.byu.edu/content/introduction-microelectromechanical-systems-MEMS

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO2
CO1	2	3	1	3	2	2	2	-	2	-	3	2	1	1
CO2	1	2	2	1	2	2	-	3	2	2	2	2	2	1
CO3	2	3	2	-	-	2	2	1	-	-	2	1	-	2
CO4	3	2	2	2	2	1	1	2	3	-	1	-	2	3
CO5	2	2	1	-	1	3	2	1	3	2	2	1	-	-

MT16904 BIOMEDICAL INSTRUMENTATION 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- make the students to understand the role of instrumentation in bio medicalapplications.
- gain adequate knowledge on ECG, EEG and EMG.
- introduce the methods for conditioning.
- analyse parameters of medical imaging and its measurements.
- introduce the basis of signal conversion.

UNIT I INTRODUCTION 9

Cell structure - electrode - electrolyte interface - electrode potential - resting and action potential - electrodes for their measurement - ECG, EEG, EMG and EOG - machine description - methods of measurement - stem cells.

UNIT II BIO MEDICAL SENSORS AND TRANSDUCERS 9

Basic transducer principles - types - source of bio electric potentials - resistive, inductive, capacitive, fiber - optic, photoelectric, chemical; Active and passive transducers and their description and feature applicable for biomedical instrumentation.

UNIT III SIGNAL CONDITIONING, RECORDING AND DISPLAY 9

Input isolation - D.C amplifier - charge amplifier - power amplifier and differential amplifier - feedback Op-amp - electrometer amplifier - carrier amplifier - instrument power supply - oscillography - galvanometric - XY magnetic recorder - storage oscilloscopes - electron microscope - PMMC writing systems - telemetry principles.

UNIT IV MEDICAL MEASUREMENT AND MONITORING SYSTEMS 9

Blood pressure measurement - ultrasonic method - plethysmography - blood flow measurement - electromagnetic flow meter - cardiac output measurement - dilution method - phonocardiography - vector cardiography; Heart lung machine - artificial ventilator - Anesthetic machine - Basic ideas of CT scanner - MRI - ultrasonic scanner laser equipment and application - cardiac pacemaker - DC - defibrillator patient safety - electrical shock hazards.

UNIT V BIO MEDICAL DIAGNOSTIC INSTRUMENTATION 9

Introduction - computers in medicine - basis of signal conversion and digital filtering - data reduction technique - time and frequency domain technique - Biomatics.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- gain adequate knowledge on ECG, EEG and EMG.
- acquire knowledge on characteristics and applications of a variety of signal transducers.
- understand the various recording and display devices.
- distinguish between various health measurement and monitoring system.
- familiarize various medical equipment's and their technical aspects.

TEXT BOOKS

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014.
2. Cromwell, Weibell and Pfeiffer, Biomedical Instrumentation and Measurements, Prentice Hall of India Learning Ltd., New Delhi, 2011.

REFERENCES

1. R. Ananda Natarajan, Biomedical Instrumentation and Measurements, Prentice-Hall of India Pvt.Ltd; 2nd revised edition, 1995.
2. L. A. Geddes and Baker, L.E., Principles of Applied Bio-medical Instrumentation, John Wiley and Sons Publishing Company, New York, 1995.
3. W. J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India Learning. Ltd., New Delhi, 2000.

WEB LINK

1. https://study.com/articles/Biomedical-Instrumentation-Courses-and-Training-Programs.html
2. http://www.tankonyvtar.hu/en/tartalom/tamop412A/2011-0079-jobbagy-biomedical/ch02.html
3. https://www.igi-global.com/article/biomedical-instrumentation/148682

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

	Programme Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	3	-	2	1	1	3	3	1	2	3	3
CO2	1	1	3	-	1	1	3	3	2	1	1	3	-	1
CO3	2	1	-	1	-	-	-	2	3	2	1	-	3	2
CO4	-	-	2	2	3	3	2	1	-	-	3	2	-	3
CO5	1	1	-	-	1	3	-	-	1	1	-	1	2	-

MT16905 NON - DESTRUCTIVE TESTING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- explain the concept of non-destructive evaluation.
- access knowledge on various types of non-destructive evaluation methods.
- identify the principles and working of different NDT methods.
- compose knowledge on selection of such different methods for testing and evaluation of various components minimum values.
- identify the concept of ultrasonic testing methods.

UNIT I INTRODUCTION AND LIQUID PENETRANTS TESTING 9

Non-destructive testing (NDT) and its importance - NDT vs Destructive Testing - Visual Examination - Basic Principles, optical aids used and applications. Liquid Penetrants - Principles, Procedure for penetrants testing, Penetrants testing methods, Post emulsification, properties of liquid penetrants, sensitivity, applications and Limitations - Standards.

UNIT II MAGNETIC PARTICLE TESTING 9

Magnetic Particle Testing - Principles, Magnetizing techniques, Procedures, Equipment, Sensitivity, Applications and Limitations- Standards. Case studies.

UNIT III ULTRASONIC TESTING 9

Properties of sound beam, Transducers, inspection methods, Techniques for Normal and angle beam inspection, Flaw characterization-equipment, and methods of display - A - Scan, B - Scan, C - Scan, Immersion testing - application, advantages and limitations - standards.

UNIT IV RADIOGRAPHY 9

Electromagnetic radiation sources - X-ray production and gamma ray sources, properties, radiation - attenuation and effects in film, Exposure charts - radiographic imaging - inspection techniques - applications and limitations - safety in industrial radiography - neuron radiography - standards. Case studies.

UNIT V EDDY CURRENT 9

Principles, Instrumentation, Techniques, Probe, Sensitivity, Advanced Test Methods, applications & limitations standards. Other Techniques: Acoustic Emission Testing Principle, Techniques, Instrumentations, Applications and Standards, Homography Thermography - Principles, Equipment, Techniques, Applications and Standards, Leak testing - methods, detection and Standards. Selection of NDT Methods: Defects in material - Selection of NDT and Instrumentation - Some Case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- access the knowledge about working liquid penetrants testing.
- identify the non-destructive evaluation methods for magnetic particle testing.
- identify the ultrasonic testing methods and working processes.
- relate the knowledge about the sources, process and safety precautions of x-ray radiography.
- locate the test performance on eddy current techniques.

TEXT BOOKS

1. Baldev Raj, T. Jayakumar and M. Thavsimuthu, "Practical Non-Destructive Testing" 3rd Edition, NarosaPublishingHouse, NewDelhi, 2009.
2. Shull Peter J, Non Destructive Evaluation: Theory-Techniques and Applications‖, Marcel Dekkar Inc., New York, USA, 2002.

REFERENCES

1. Baldev Rajand Venkatraman B., Practical Radiology, Narosa Publishing House, NewDelhi, 2004.
2. Hull Barryand JohnVernon, Non Destructive Testing, 1st Edition, Macmillan, London, 1988.
3. Brichan D., Non Destructive Testing‖, Oxford Press, 1975.
4. ASM Handbook, Non Destructive Evaluation and Quality Control, Vol.17, 9thEdition, 1989.

WEB LINKS

1. http://www.asnt.org/MinorSiteSections/AboutASNT/Intro-to-NDT
2. http://www.trainingndt.com/what-is-nondestructive-testing
3. http://www.twi-global.com/capabilities/integrity-management/non-destructive-testing/ndt-techniques.

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