ANNA UNIVERSITY, CHENNAI

NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY

M.E. COMPUTER INTEGRATED MANUFACTURING

REGULATIONS - 2021

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS CURRICULAR AND SYLLABI

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To train students to independently carry out research / investigations and development work to solve practical problems.
2. To train students to write and present a technical report/ documents.
3. To train students to demonstrate mastery in the area of computer integrated manufacturing at a higher level.
4. To train students to pursue professional career in manufacturing industries/educational institutions/research & development organisations as well as in allied fields and excel as an individual and also as a team player in multidisciplinary environments.
5. To train students to provide solutions to industrial/research problems considering economic, environmental and social contexts for sustainable development.
6. To train students to solve technical problems with creativity, innovation, confidence and self-responsibility.

2. PROGRAMME OUTCOMES (POs):

The programme outcomes of the Computer Integrated Manufacturing Postgraduate students are given below:

PO 1: Ability to independently carry out research / investigations and development work to solve practical problems.

PO 2: Ability to write and present a substantial technical report/ documents.

PO 3: Ability to demonstrate mastery in the area of computer integrated manufacturing at a higher level.

PO 4: Ability to pursue professional career in manufacturing industries/educational institutions/research & development organisations as well as in allied fields and excel as an individual and also as a team player in multidisciplinary environments.

PO 5: Ability to provide solutions to industrial/research problems considering economic, environmental and social contexts for sustainable development.

PO 6: Ability to solve technical problems with creativity, innovation, confidence and self-responsibility.

PROGRAM ARTICULATION MATRIX

Year	Semester	Course name	PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	Semester 1	Applied Probability and Statistics for Manufacturing Engineering						
		Computer Applications in Design	2	3	2		3	
		Computer Aided Manufacturing	1.6	2.2	2.6	2	2.4	2.6
		Solid Freeform Manufacturing	2.8	2.8	2	3	2.5	1.4
		Research Methodology and IPR						
		Industrial Robotics						
		Audit Course – I						
		Computer Aided Design and Computer Aided Engineering Laboratory	2.4	2.25	2.25	1.66	2	1.75
		Computer Aided Manufacturing Laboratory	1		3	2		
	Semester 2	Advanced Metrology	2.6	1.25	1.2	2	1.2	2.2
		Manufacturing Planning and Control Systems	3	3	3	2.5	2.4	
		Competitive Manufacturing Systems	2.6		3		3	
		Mechatronics in Manufacturing Systems	3	3	3		3	
		Professional Elective - I						
		Professional Elective - II						
		Audit Course – II						
		Advanced Metrology Laboratory	2.6	1.25	1.2	2	1.2	2.2
		Automation and Robotics Laboratory	2.4	2.25	2.25	1.66	2	1.75
		Technical Seminar						
Year 2	Semester 3	Professional Elective - III						
		Professional Elective - IV						
		Professional Elective - V						
		Open Elective						
		Project Work I	3	3	3	3	3	3
		Project Work II	3	3		3	3	3

4. PEO/PO MAPPING:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
I	√	√	√		√	√
II	√	√				
III						√
IV	√		√	√	√	√
V	√		√	√	√	

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I TO IV SEMESTERS CURRICULA AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4155	Applied Probability and Statistics for Manufacturing Engineering	FC	3	1	0	4	4
2.	ED4153	Computer Applications in Design	PCC	3	0	0	3	3
3.	CM4151	Computer Aided Manufacturing	PCC	3	0	0	3	3
4.	CM4152	Solid Freeform Manufacturing	PCC	3	0	0	3	3
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.	CM4101	Industrial Robotics	PCC	3	0	0	3	3
7.		Audit Course I*	AC	2	0	0	2	0
PRACTICAL								
8.	CM4111	Computer Aided Design and Computer Aided Engineering Laboratory	PCC	0	0	4	4	2
9.	CM4161	Computer Aided Manufacturing Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**8**	**28**	**22**

* Audit Course is optional

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	CM4201	Advanced Metrology	PCC	3	0	0	3	3
2	CM4202	Manufacturing Planning and Control Systems	PCC	3	0	0	3	3
3.	CM4203	Competitive Manufacturing Systems	PCC	3	0	0	3	3
4.	CM4204	Mechatronics in Manufacturing Systems	PCC	3	0	0	3	3
5.		Professional Elective - I	PEC	3	0	0	3	3
6.		Professional Elective - II	PEC	3	0	0	3	3
7.		Audit Course II*	AC	2	0	0	2	0
PRACTICAL								
8.	CM4211	Advanced Metrology Laboratory	PCC	0	0	4	4	2
9.	CM4212	Automation and Robotics Laboratory	PCC	0	0	4	4	2
10.	CM4213	Technical Seminar	EEC	0	0	2	2	1
			TOTAL	**20**	**0**	**10**	**30**	**23**

* Audit Course is optional

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective - III	PEC	3	0	0	3	3
2.		Professional Elective - IV	PEC	3	0	0	3	3
3.		Professional Elective - V	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
5.	CM4311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**12**	**24**	**18**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	CM4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75

PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVES I & II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CM4001	Advances In Manufacturing Technology	PEC	3	0	0	3	3
2.	CM4002	Computer Aided Process Planning	PEC	3	0	0	3	3
3.	CM4003	Design for Manufacturing	PEC	3	0	0	3	3
4.	CM4004	Design of Cellular Manufacturing System	PEC	3	0	0	3	3
5.	CM4005	Finite Element Analysis in Manufacturing Engineering	PEC	3	0	0	3	3
6.	CM4006	Advances in Welding and Casting Technology	PEC	3	0	0	3	3
7.	CM4007	Precision Engineering	PEC	3	0	0	3	3
8.	MF4091	Manufacturing Management	PEC	3	0	0	3	3
9.	CM4008	Applied Materials Engineering	PEC	3	0	0	3	3
10.	CM4009	Micro and Nano Manufacturing	PEC	3	0	0	3	3
11.	IL4093	Supply Chain Management	PEC	3	0	0	3	3
12.	IL4075	Lean Manufacturing and Six Sigma	PEC	3	0	0	3	3
13.	IL4071	Advanced Optimization Techniques	PEC	3	0	0	3	3
15.	CM4010	Machine Learning	PEC	3	0	0	3	3

SEMESTER III
ELECTIVE III, IV & V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CM4072	Electronics Manufacturing Technology	PEC	3	0	0	3	3
2.	CM4011	Environment Conscious Manufacturing	PEC	3	0	0	3	3
3.	CM4012	Evolutionary Computation	PEC	3	0	0	3	3
4.	CM4013	Intelligent Product Design and Manufacturing	PEC	3	0	0	3	3
5.	CM4014	Intelligent Manufacturing Systems	PEC	3	0	0	3	3
6.	CM4015	Micro Electro Mechanical Systems	PEC	3	0	0	3	3
7.	PD4391	Product Lifecycle Management	PEC	3	0	0	3	3
8.	CM4071	Manufacturing System Simulation	PEC	3	0	0	3	3

9.	CM4016	Manufacturing Information Systems	PEC	3	0	0	3	3
10.	CM4017	Sustainable Manufacturing	PEC	3	0	0	3	3
11.	IL4072	Enterprise Resource Planning	PEC	3	0	0	3	3
12.	CC4071	Advanced Machine Tool Design	PEC	3	0	0	3	3
13.	CM4018	Management of Manufacturing Systems	PEC	3	0	0	3	3
14.	CM4019	Design of Fluid Power Systems	PEC	3	0	0	3	3
15.	IL4092	Project Management	PEC	3	0	0	3	3
16.	CM4020	Reliability and Total Productive Maintenance	PEC	3	0	0	3	3
17.	CM4021	Sensors for Manufacturing and Condition Monitoring	PEC	3	0	0	3	3
18.	CM4091	Green Manufacturing	PEC	3	0	0	3	3
19.	CM4022	Material Characterization Techniques	PEC	3	0	0	3	3
20.	CM4023	Tool Engineering	PEC	3	0	0	3	3
21.	CM4024	Total Quality Systems and Engineering	PEC	3	0	0	3	3
22.	CM4025	Warehouse Layout Planning and Part Feeding Methods	PEC	3	0	0	3	3
23.	MR4071	Internet of Things for Manufacturing	PEC	3	0	0	3	3
24.	IS4071	Data Analytics	PEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OBA431	Sustainable Management	3	0	0	3
8.	OBA432	Micro and Small Business Management	3	0	0	3
9.	OBA433	Intellectual Property Rights	3	0	0	3
10.	OBA434	Ethical Management	3	0	0	3
11.	ET4251	IoT for Smart Systems	3	0	0	3
12.	ET4072	Machine Learning and Deep Learning	3	0	0	3
13.	PX4012	Renewable Energy Technology	3	0	0	3
14.	PS4093	Smart Grid	3	0	0	3
15.	CP4391	Security Practices	3	0	0	3
16.	MP4251	Cloud Computing Technologies	3	0	0	3
17.	IF4072	Design Thinking	3	0	0	3
18.	MU4153	Principles of Multimedia	3	0	0	3
19.	DS4015	Big Data Analytics	3	0	0	3
20.	NC4201	Internet of Things and Cloud	3	0	0	3
21.	MX4073	Medical Robotics	3	0	0	3
22.	VE4202	Embedded Automation	3	0	0	3
23.	CX4016	Environmental Sustainability	3	0	0	3
24.	TX4092	Textile Reinforced Composites	3	0	0	3
25.	NT4002	Nanocomposite Materials	3	0	0	3
26.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

MA4155	APPLIED PROBABILITY AND STATISTICS FOR MANUFACTURING ENGINEERING	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1. To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
2. To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables.
3. To apply the small and large sample tests through test of hypothesis.
4. To understand the basic concepts of sampling distributions and statistical properties of point estimators.
5. To understand the concept of analysis of variance and use it to investigate factorial dependence.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT III TESTING OF HYPOTHESIS 12

Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

UNIT IV ESTIMATION THEORY 12

Interval estimation for population mean - Standard deviation - Difference in means, proportion ratio of standard deviations and variances.

UNIT V DESIGN OF EXPERIMENTS 12

Completely randomized design – Randomized block design – Latin square design – 2^2 Factorial design.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

1. Analyze the performance in terms of probabilities and distributions achieved by the determined solutions.
2. Be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.
3. Apply the basic principles underlying statistical inference(hypothesis testing).
4. Demonstrate knowledge of applicable large sample theory of estimators and tests.
5. Obtain a better understanding of the importance of the methods in modern industrial processes.

REFERENCES :

1. Devore, J. L., "Probability and Statistics for Engineering and Sciences", 8th Edition, Cengage Learning, 2014.
2. Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics", 12th Edition, Sultan and Sons, New Delhi, 2020.
3. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, Asia, 2016.
4. Rice, J. A., "Mathematical Statistics and Data Analysis", 3rd Edition, Cengage Learning, 2015.
5. Ross, S. M., "Introduction to Probability and Statistics for Engineers and Scientists", 5th Edition, Elsevier, 2014.

ED4153	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand fundamental concepts of computer graphics and its tools in a generic framework.
- To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
- To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.
- To provide clear understanding of CAD systems for 3D modeling and viewing.
- To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

UNIT – I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software.

Output primitives: Line Drawing Algorithm - DDA, Bresenham's and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm.

Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations-Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

UNIT – II CURVES AND SURFACES MODELLING 9

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT – III NURBS AND SOLID MODELING 9

NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

UNIT – IV VISUAL REALISM 9

Hidden Line removal, Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring.

Animation - Conventional, Computer animation, Engineering animation - types and techniques.

UNIT – V ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT 9

Assembly modeling – Design for manufacture – Design for assembly – computer aided DFMA - inferences of positions and orientation - tolerances analysis –Center of Gravity and mass property calculations - mechanism simulation. Graphics and computing standards - Data Exchange standards. Product development and management – new product development –models utilized in various phases of new product development – managing product life cycle.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Solve 2D and 3D transformations for the basic entities like line and circle.
2. Formulate the basic mathematics fundamental to CAD system.
3. Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.
4. Create geometric models through animation and transform them into real world systems
5. Simulate assembly of parts using Computer-Aided Design software.

REFERENCES:

1. Boothroyd, G, "Assembly Automation and Product Design" Marcel Dekker, New York, 1997.
2. Chitale A.K and Gupta R.C " Product design and manufacturing " PHI learning private limited, 6th Edition, 2015.
3. David Rogers, James Alan Adams "Mathematical Elements for Computer Graphics" 2nd Edition, Tata McGraw-Hill edition.2003
4. Donald D Hearn and M. Pauline Baker "Computer Graphics C Version", Prentice Hall, Inc., 2nd Edition, 1996.
5. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006
6. William M Newman and Robert F.Sproull "Principles of Interactive Computer Graphics", McGraw Hill Book Co. 1stEdition, 2001.

0.3- Low 0.6- Medium 0.9- High

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	2		3	
2	2	3	2		3	
3	2	3	2		3	
4	2	3	2		3	
5	2	3	2		3	
Avg	(10/5)=2	(15/5)=3	(10/5)=2		(15/5)=3	

CM4151 COMPUTER AIDED MANUFACTURING L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce the evolution of CAD, CAM, CIM, engineering product specification and interpreting geometric specifications.
- To train the candidates on the integration of Computer Aided Design and Computer Aided Manufacturing.
- To impart knowledge on manual part program and generation of CNC part program using Computer Aided Manufacturing packages.
- To introduce with the implementation of CAD and CAM in manufacturing process.
- To introduce the importance of Internet of Things in Computer Aided Manufacturing.

UNIT I INTRODUCTION TO CAM 9

Introduction CAD, CAM, CAE, CIM, system configuration for CAM including hardware and software, evolution of product realization, historical development, engineering product specification. Geometric Tolerancing - ASME standard, interpreting geometric specifications, multiple part features and datum.

UNIT II CAD AND CAM INTEGRATION 9

Introduction - Networking - Techniques, components, interface cards, network standards, Graphics standards - Graphical kernel system, Data exchange format - IGES and STEP.
Process planning, Computer Aided Process Planning (CAPP), Product life cycle management (PLM), Enterprise resource planning (ERP).

UNIT III PROGRAMMING OF CNC MACHINES 9

Structure of CNC program, Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, mirroring features, Manual part programming for CNC turning, machining center, wire electric discharge machining, abrasive water jet cutting machine, bulk and sheet metal forming, generation of CNC program using CAM softwares.

UNIT IV CAD AND CAM FOR MANUFACTURING PROCESSES 9

Classification of Manufacturing process, construction and operations, Integration of CAD and CAM in CNC turning center, machining center, electric discharge machining, wire electric discharge machining, abrasive water jet cutting machine, bulk forming, sheet metal forming.

UNIT V IOT IN CAM 9

Introduction, overview of IOT enabled manufacturing system, Real-time and multi-source manufacturing information sensing system, IOT enabled smart assembly station, cloud computing based manufacturing resources configuration method, Real-time key production performances analysis method, Real-time information driven production scheduling system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Recognize the importance of CAD, CAM, CIM, Engineering product specification and interpreting geometric specifications.
CO2: Improve knowledge on the integration of CAD and CAM.
CO3: Exhibit competency in manual part program and generation of CNC part program using CAM packages.
CO4: Describe the implementation of CAD and CAM in manufacturing processes.
CO5: Explain applications of IOT in computer aided manufacturing.

REFERENCES:

1. Chang T.C., Wysk, R.A. and Wang.H.P., “Computer Aided Manufacturing”, Pearson Prentice Hall, India ,2009, ISBN: 978-0131429192.
2. HMT,“Mechatronics”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017.
3. Rao P.N., “CAD/CAM”, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, India, 2012, ISBN-13: 978-0070681934.
4. Radhakrishnan P., “Computer Numerical Control ", New Central Book Agency, India,2013.
5. Nee Y.C., Soh K. Ong, Yun G. Wang., “Computer Applications in Near Net-Shape Operations”, Springer, United Kingdom, 2012.
6. Yingfeng Zhang and Fei Tao, “Optimization of Manufacturing Systems Using the Internet of Things” Academic Press, United Kingdom, 2017.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	2	3	2	2	3
CO2	1	1	2	1	2	2
CO3	2	3	2	3	3	3
CO4	3	3	3	3	3	3
CO5	1	2	3	1	2	2
Avg	(8/5)=1.6	(11/5)=2.2	(13/5)=2.6	(10/5)=2	(12/5)=2.4	(13/5)=2.6

CM4152 SOLID FREEFORM MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), proliferation into various fields and its effects on supply chain.
- To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.
- To acquaint with polymerization and sheet lamination processes and their applications.
- To acquaint with material extrusion and powder bed fusion processes.
- To gain knowledge on jetting and direct energy deposition processes and their applications.

UNIT I INTRODUCTION 9

Need - Development of SFM systems – Hierarchical structure of SFM - SFM process chain – Classification – Applications. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect- Operative aspect.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation - Topology Optimization - Lightweight Structures - DFAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats - Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation. Design Requirements of Additive Manufacturing: For Part Production, For Mass Production, For Series Production. Case Studies.

UNIT III VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES 9

Stereolithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications.

Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies.

UNIT IV MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES 9

Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM.

Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Multijet Fusion.

Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications. Case Studies.

UNIT V JETTING AND DIRECT ENERGY DEPOSITION PROCESSES 9

Binder Jetting: Three dimensional Printing (3DP): Principles – Process - Physics of 3DP - Types of printing: Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications.

Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

Laser Engineered Net Shaping (LENS): Processes- Materials- Advantages - Limitations and Applications. Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Relate the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.

CO2: Analyze the design for AM and its importance in the quality of fabricated parts.

CO3: Build knowledge on principles and applications of polymerization and sheet lamination processes with case studies.

CO4: Explain the principles of material extrusion and powder bed fusion processes and design guidelines.

CO5: Elaborate jetting and direct energy deposition processes and their applications.

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hotter, “Additive Manufacturing:3D Printing for Prototyping and Manufacturing”, Hanser publications Munchen, Germany, 2016. ISBN:978-1-56990-582-1.
2. Ben Redwood, Brian Garret, FilemonSchöffer, and Tony Fadel, “The 3D Printing Handbook: Technologies, Design and Applications”, 3D Hubs B.V., Netherland, 2017. ISBN-13: 978-9082748505.
3. Ian Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer - New York, USA, 2nd Edition, 2015. ISBN-13: 978-1493921126.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 1st Edition, 2007 FL, USA. ISBN- 9780849334092.
5. Milan Brandt., “Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications”, Woodhead Publishing, UK, 2016. ISBN- 9780081004333.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	3	1	3	3	2
CO2	3	2	3	3	3	2
CO3	3	3	2	3	2	1
CO4	3	3	2	3	2`	1
CO5	3	3	2	3	2	1
Avg	(14/5)=2.8	(14/5)=2.8	(10/5)=2	(15/5)=3	(10/4)=2.5	(7/5)=1.4

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.
Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association.
Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL : 30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

CM4101 INDUSTRIAL ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors.
Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL 9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III ROBOT SENSORS 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 8

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The student will be able to design robots and robotic work cells and write program for controlling the robots. The student will be able to apply artificial intelligence and expert systems in robotics.

REFERENCES

1. Deb, S.R." Robotics Technology and Flexible Automation", Tata McGraw-Hill, 2009.
2. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", McGraw-Hill, Int., 1986.
3. Jordanides,T. and Torby,B.J., ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.
4. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
5. Klafter,R.D., Chmielewski, T.A. and Negin,M., "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 2003.
6. Koren,Y., "Robotics for Engineers", McGraw-Hill, 1987.
7. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2		3	1	1	1
CO2	2		3	1	1	1
CO3	2		3	1	1	1
CO4	2		3	1	1	1
CO5	2		3	1	1	1
Avg	(10/5)=2		(15/5)=3	(5/5)=1	(5/5)=1	(5/5)=1

CM4111 **COMPUTER AIDED DESIGN AND COMPUTER AIDED ENGINEERING LABORATORY** **L T P C 0 0 4 2**

COURSE OBJECTIVES:

- To familiarize the students with CAD and CAE modules.
- To create basic sketches and to design part modelling for the given mechanical components.
- To generate assemblies from the part model with respect to the constraints and to various data exchange formats.
- To familiarize the students with reverse engineering as a tool to create 3D models for 3D printing.
- To gain practical knowledge in CAE module through Finite Element Analysis.

LIST OF EXPERIMENTS:

CAD MODULE

1. Sketching and Part modelling (Solid modelling, Surface modelling, Feature manipulation) of mechanical components using CAD software package.
2. Assembly (Constraints, Exploded Views, Interference check) and Drafting (Layouts, Geometric Dimensions &Tolerance Standards, Sectional Views, & Detailing) of mechanical components using CAD software package.
3. Working with CAD Data Exchange formats: IGES, PDES, PARASOLID, DXF and STL
4. Study and exercise on freeform modelling.
5. Reverse engineering the given product/component and convert the data into 3D model.
6. Exercise on. STL file Preparation, Slicing, Support Structure Generation & Build setup Preparation.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Apply knowledge on CAD and CAE modules.

CO2: Build and design interactive CAD models.

CO3: Interpret the given mechanical components and to design for 3D printing.

CO4: Demonstrate the use of FEA package.

CO5: Make use of assemble parts, evaluate the information and resources using FEA.

LIST OF ITEMS (HARDWARE/SOFTWARE) REQUIRED:

1. Computers 24 Nos.
2. CAD software Package
3. Open source CAD software for Additive Manufacturing
4. CAE Software package

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3				3	
CO2	1	1	3			1
CO3	2	3	1	2		2
CO4	3	3	2	1	2	3
CO5	3	2	3	2	1	1
Avg	(12/5)=2.4	(9/4)=2.25	(9/4)=2.25	(5/3)=1.66	(6/3)=2	(7/4)=1.75

CM4161 COMPUTER AIDED MANUFACTURING LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- To familiarize students with manual CNC part programming for milling and turning machines.
- To generate part programs using CAM packages for milling and turning machines.
- To train students with dimensional and geometric measurements for machined features using video measuring system and coordinate measuring machine.
- To get hands on knowledge on programming logic controller - ladder programming and robot programming.
- To introduce the concept of printing parts using additive manufacturing and to introduce Relational database management system in Material requirements planning.

LIST OF EXPERIMENTS

1. Programming and simulation for various operations using canned cycle for CNC turning Centre.
2. Programming and simulation for machining of internal surfaces in CNC turning Centre
3. Programming and simulation for profile milling operations
4. Programming and simulation for circular and rectangular pocket milling
5. Programming and simulation using canned cycle for CNC Milling such as peck drilling and tapping cycle
6. CNC code generation using CAM software packages – Milling
7. CNC code generation using CAM software packages – Turning
8. Dimensional and geometric measurement of machined features using VMS and CMM
9. PLC ladder logic programming.
10. Robot programming for Material handling applications.
11. Study on RDBMS and its application in problems like inventory control MRP.
12. Design and fabrication of a component using extrusion based additive manufacturing.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Explain the manual CNC part programming for milling and turning machines.

CO2: Create part programs using CAM packages for milling and turning Machines.

CO3: Appraise dimensional and geometric measurements of machined features using video measuring system and coordinate measuring machine.

CO4: Construct PLC ladder programming and robot programming.

CO5: Relate the concept of printing parts using additive manufacturing and appreciate the application RDBMS in MRP.

LIST OF EQUIPMENTS REQUIRED:

1. Computers 30
2. CAM Software for 3 axis machining or more
3. CNC Production type turning or Machining center
4. Video Measuring System
5. Coordinate Measuring Machine
6. Surface Roughness tester
7. 5 -axis Robot
8. Programmable Logic Controller with ladder logic programming software
9. RDMBS Package with relevant modules like Inventory Control and MRP
10. 3D Printer

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		3	2		
CO2	1		3	2		
CO3	1		3	2		
CO4	1		3	2		
CO5	1		3	2		
Avg	(5/5)=1		(15/5)=3	(10/5)=2		

CM4201 **ADVANCED METROLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To teach the concepts of metrology.
- To train the students in various aspects of measurement of surface roughness.
- To train the students in the area of interferometry and form measurements.
- To train the students with understanding the fundamental principles of computer aided inspection and laser metrology.
- To introduce the basic principles of image processing and machine vision in context to metrological applications.

UNIT I CONCEPTS OF METROLOGY **9**

Introduction – Terminologies – Standards of measurement – Interchangeability – Selective assembly – Accuracy and Precision – Calibration of instruments – Errors in measurements – Laboratory accreditation, Basics of dimensional metrology and Form metrology – Clean room – Maintenance and handling of metrology equipment's – Standard practices of inspection rooms.

UNIT II MEASUREMENT OF SURFACE ROUGHNESS **9**

Introduction – Types of Surface Texture – Surface Roughness Measurement Methods – Roughness parameters, bearing area parameters, Contact and Non-Contact type roughness measuring instruments, 3D Surface Roughness Measurement – Nano Level Surface Roughness Measurement – Instruments: Scanning Electron Microscope(SEM), Transmission Electron Microscope(TEM), Scanning and Transmission Electron Microscope(STEM), Atomic Force Microscopy(AFM).

UNIT III INTERFEROMETRY **9**

Introduction – Principles of Interferometry – Optical flats in assessing surface contours - Interferometers – Measurement and Calibration – Laser Interferometry – Engineering applications of interferometry.

UNIT IV COMPUTER AIDED INSPECTION AND LASER METROLOGY **9**

Introduction – Computer Aided Inspection Techniques – Tool Makers Microscope – Coordinate Measuring Machines – Applications – Advanced Laser gauging techniques – Lasers in precision Measurements – Laser Scanners for Reverse Engineering – In-process inspection -Industrial case studies.

UNIT V MACHINE VISION AND IMAGE PROCESSING **9**

Introduction – Machine vision – Overview – Computer imaging systems, Image Analysis, Preprocessing, Human Vision System, Image model, Image enhancement, gray scale models, histogram models, Image Transforms – Applications of image processing -Advantages and limitations and Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Illustrate the fundamental concepts of measurement, standards, calibration, maintenance of laboratory facilities and handling of metrological equipments.

CO2: Explain the roughness and its applications in manufacturing research, learn the important concepts, principles and applications related to interferometry.

CO3: Justify the use of interferometry related sophisticated measurement and inspection facilities.

CO4: Relate the concepts of Computer aided inspection technologies for industrial Situations, design and develop new inspection techniques.

CO5: Discuss the importance of image processing techniques and the possibilities of developing new heuristics for image processing related to metrology.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	2	2		1
CO2	2			2		1
CO3	1	1	1	1		
CO4	3	1	2	2	1	2
CO5	3	1	2	2	2	2
Avg	(11/5)=2.2	(4/4)=1	(7/4)=1.75	(9/5)=1.8	(3/2)=1.5	(6/4)=1.5

REFERENCES:

1. "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., India,1992.
2. Bewoor A.K. and Kulkarni V.A.,"Metrology and Measurement", Tata McGraw-Hill, India, 2009.
3. Galyer F.W. and Shotbolt C.R., "Metrology for engineers", ELBS, Germany, 1990.
4. Jain R.K., "Engineering Metrology", Khanna Publishers, India, 2008.
5. Smith G.T., "Industrial Metrology", Springer, United States, 2002.

CM4202 MANUFACTURING PLANNING AND CONTROL SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To introduce students with Current Trends in Manufacturing Planning and Control System and Forecasting activities.
- To impart basic concepts of Aggregate Production Planning.
- To elaborate on Inventory management and Resource Requirements.
- To be familiarized with the functions of Shop Floor Control and associated systems.
- To gain knowledge on Computer Process Monitoring, Computer Process Interfacing and Process Control Strategies.

UNIT I MANUFACTURING PLANNING AND CONTROL AND FORECASTING 9

Introduction: Production Planning and Control-Limitations with Traditional Production Planning and Control**-**Need and Evolution of Manufacturing Planning and Control (MPC) System -Basic framework - Demand Management in MPC System- Forecasting**:** Time Horizon, Design of Forecasting Systems - Developing the Forecast Logic– Qualitative methods: Delphi Technique, Market Research, Quantitative methods -Time Series - Moving Averages, Exponential Smoothing -Regression- Measure of Forecast Accuracy- Numerical Problems

UNIT II AGGREGATE PRODUCTION PLANNING 9

Introduction-Need for Aggregate production planning (APP) - Alternatives for Managing Demand-Reservation of Capacity, Influencing Demand - Alternatives for Managing Supply - Inventory based Capacity Adjustment, Capacity Augmentation, Basic Strategies - Level, Chase, Mixed - Numerical Problems - APP Methods - Heuristic Methods, Optimal Methods.

UNIT III RESOURCE PLANNING 9

Inventory Management - Inventory Types and Control Procedures - Order point systems - Inventory Management Module - Rough-Cut Capacity Planning- Master Production Schedule - Material Requirements Planning (MRP) - Basic Concepts of MRP -Inputs to MRP- MRP Logic - Capacity Requirements Planning - Distribution Requirements Planning - Manufacturing Resource Planning (MRP II) - Enterprise Resource Planning (ERP)-Case studies.

UNIT IV SHOP FLOOR CONTROL 9

Shop Floor Control - Functions - Shop Floor Control System - Order Release - Order Scheduling - Order Progress - Operation Scheduling-Priority Rules for Job Sequencing - The Factory Data Collection System - Online and Offline Data Collection Systems - Case studies.

UNIT V PROCESS MONITORING AND CONTROL 9

Computer Process Monitoring: Data Logging Systems - Data Acquisition Systems - Multilevel Scanning - Computer Control: Computer-Process Interfacing - Manufacturing Process Data - System Interpretation of Process Data - Interface Hardware Devices - Digital Input / Output Processing Interrupt system - Control Programming - Computer Process Control - Structural Model of a Manufacturing Process - Process Control Strategies-Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Evaluate the various activities of Manufacturing Planning and Control System and Forecasting activities.

CO2: Outline the concepts of Aggregate Production Planning.

CO3: Organize the Inventory management and Resource Requirements.

CO4: Develop the functions of Shop Floor Control and associated systems.

CO5: Simplify the computer Process Monitoring, Computer Process Interfacing and Process Control Strategies.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	3	3	2	2	
CO2	3	3	3	3	2	
CO3	3	3	3	3	2	
CO4	3		3	2	3	
CO5	3		3		3	
Avg	(15/5)=3	(9/3)=3	(15/5)=3	(10/4)=2.5	(12/5)=2.4	

REFERENCES

1. Groover M. and Zimmers E., “CAD/CAM: Computer-Aided Design and Manufacturing”, Prentice Hall., India, Reprint 2013, ISBN-13: 978-0131101302.
2. Mahadevan B., "Operations Management: Theory and practice", Pearson., India, 2015, ISBN-13: 978-9332547520.
3. Mahapatra P.B., “Computer-Aided Production Management”, Prentice-Hall, India, 2004, ISBN-13: 978-8120317420.
4. Nanua Singh, "System Approach to Computer Integrated Design and Manufacturing", Wiley India Edition, Reprint 2011, ISBN-13: 978-0471585176.
5. Thomas E. Vollmann, William Lee Berry, David Clay Whybark and Robert Jacobs F., “Manufacturing Planning and Control Systems for Supply Chain Management”, McGraw Hill., United States, 2014, ISBN: 9789339205331.

CM4203 COMPETITIVE MANUFACTURING SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To expose students on the areas of competitive environment, the best manufacturing practices in the world.
- To impart the concepts of group technology and flexible manufacturing systems.
- To gain knowledge in simulation techniques of flexible manufacturing systems.
- To outline computer software and database of flexible manufacturing systems.
- To familiarize the principles of just in time manufacturing systems.

UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT 9

Introduction – Competitiveness - Cost, Time, Quality, Flexibility - Product flexibility, Operation flexibility, Capacity flexibility - Automation of Manufacturing Process - Numerical Control - Adaptive Control - Material Handling and Movement - Industrial Robots - Sensor Technology - Flexible Fixtures - Design for Assembly, Disassembly and Service – Product Lifecycle Management.

UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS 9

Part Families - Classification and Coding - Production Flow Analysis - Machine Cell Design – Benefits - Components of Flexible Manufacturing Systems (FMS) - Computer Control and Functions - Planning, Scheduling and Control of FMS - Knowledge Based Scheduling.

UNIT III SIMULATION OF FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction - Application of Simulation – Simulation Process - Stating the Project's Objective(s), Building the Abstract Model, Input Analysis, Building the Simulation Model, Model Verification, Model Validation, Output Analysis - Model of FMS - Simulation Software – Limitations-Case studies.

UNIT IV COMPUTER SOFTWARE AND DATABASE OF FLEXIBLE MANUFACTURING SYSTEMS 9

FMS Software - Introduction, General Structure and Requirements, Functional Descriptions, Operational Overview, Types of Software Specification and Selection - Trends. Manufacturing Data Systems - Data Flow - FMS Database Systems – Computer Aided Design/Computer Aided Manufacturing Considerations - Planning for FMS Database.

UNIT V JUST IN TIME MANUFACTURING SYSTEMS 9

Toyota Production System (TPS): An overview, Components - Introduction to Lean Manufacturing, Comparison of TPS and Lean - Three Ms - Muda, Mura and Muri - Push versus Pull Systems - Types of Kanbans - Kanban Planning and Control Models - Signal Kanban - Other types of Kanbans - Express Kanban - Emergency Kanban - Through Kanban - Level Schedules for Mixed Model Assembly Lines - Alternative JIT Systems - Just-in-time (JIT) Purchasing - Total Quality Control and JIT - JIT Implementation - Barriers, Potential Benefits.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Describe the areas of Competitive Environment and the best Manufacturing Practices in the World.

CO2: Perceive concepts of Group Technology and Flexible Manufacturing Systems.

CO3: Acquaint with Simulation of Flexible Manufacturing Systems.

CO4: Evaluate Computer Software and Database of Flexible Manufacturing Systems.

CO5: Explain Just in Time Manufacturing Systems.

REFERENCES:

1. Groover M.P., " Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
2. Jha, N.K. “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
3. Kalpkjian, “Manufacturing Engineering and Technology ", 3rd edition,Addison-Wesley Publishing Co., 1995.
4. Pascal Dennis, “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.
5. Taiichi Ohno, Toyota, " Production System Beyond Large-Scale production Productivity Press (India) Pvt.Ltd. 1992

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3		3		3	
CO2	3		3		3	
CO3	3		3		3	
CO4	2		3		3	
CO5	2		3		3	
Avg	(13/5)=2.6		(15/5)=3		(15/5)=3	

CM4204 MECHATRONICS IN MANUFACTURING SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide overview of various electrical and electronic control techniques used in modern manufacturing systems.
- To know the basic working principle of sensors and transducers of use for manufacturing systems
- To know the basic working principle of drives and actuators of use for manufacturing systems
- To know the features, modules and interfaces of microcontrollers and microprocessors
- To gain the knowledge of integration of mechatronic systems in automation of modern manufacturing systems

UNIT I INTRODUCTION TO MECHATRONICS IN MODERN MANUFACTURING 12

Introduction to Process Parameters in Conventional Manufacturing – Assembly – Inspection – Transportation - Introduction to Systems - Subsystems of Mechatronics - Identification of Mechatronics’ Entities in Modern Manufacturing - Mechanical, Fluid, Thermal, Electrical, Electronics, Communication, Control systems and Software Integration for Manufacturing - Classification of Manufacturing based on Mechatronics – CNC based Subtractive Manufacturing – Rapid Prototyping based Additive Manufacturing- Automated Assembly Stations – Modern Quality Inspection and Transportation Systems.

UNIT II SENSORS AND TRANSDUCERS 8

Introduction – Performance Terminology – Resistive Transducers – Inductive Transducers - Capacitance Transducers – Optical Sensors – Contact and Non-Contact Temperature Sensors – Eddy Current Sensor – Hall Effect Sensor – Piezo Electric Sensor - Ultrasonic Sensors – Proximity Sensors – Chemical and Gas Sensors - Signal Conditioning - Condition Monitoring

UNIT III DRIVES AND ACTUATORS 8

Role of Linear and Rotary Actuators - Electrical Actuators- Servo Concepts and Stepper Motors - Fluid Power – Piezo Actuators – Solenoids - Function of Drives - Mechanical Switching Devices – Solid State drives for various actuators

UNIT III MICROPROCESSORS AND MICROCONTROLLERS 8

Requirement for Processor – Comparison of 8085 Microprocessor and 8051 Microcontrollers– 8051 Microcontrollers Architecture -Assembly Language Programming- Instruction Set, Addressing Modes, Basic Programming – Interfacing - Sensors, Keyboard, LED, LCD, A/D and D/A Converters, Actuators – Embedded Systems

UNIT V INTEGRATION OF MANUFACTURING SYSTEMS 9

Design Process - Stages of Design Process – Skeletal Structure and Block Diagram of CNC Based - Vertical Machining Centre, turning centre, Water Jet Machine, Electrical Discharge Machine, Serial Manipulator, hydraulic press, 3 D printers– Coordinate Measuring Machine –Automated conveyors - Extended Transportation System – Total Integration of Manufacturing Systems for Production Automation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

- **CO1 :** Imply the knowledge to study the mechatronics in modern manufacturing systems.
- **CO2 :** Identify and select the sensors and transducers based on the application.
- **CO3 :** Identify the principles and functions of drives and actuators.
- **CO4 :** Get knowledge of microprocessor and microcontrollers and its functions.
- **CO5 :** Apply the knowledge about integration of mechatronic systems in manufacturing.

REFERENCES:

1. Beno Benhabib, Manufacturing, design, production, automation and integration, Marcel Dekker, 2003
2. Bolton W, — Mechatronics: Electronic control systems in mechanical and electrical engineering, 6th edition, Pearson Education Limited, 2015.
3. Devadas shetty, Richard A. Kolk, Mechatronics System Design, Cengage Learning, 2011.
4. Mazidi M A and Mazidi J G, 8051 Microcontroller and Embedded Systems, 2002.
5. Vijayaraghavan G.K., Balasundaram M S, Ramachandran K P, Mechatronics: Integrated Mechanical Electronic Systems, Wiley, 2008.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3		3	
CO2	3	3	3			
CO3	3	3	3			
CO4	3	3	3			
CO5	3	3	3		3	
Avg	15/5)=3	(15/5)=3	(15/5)=3		(6/2)=3	

CM4211 **ADVANCED METROLOGY LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To introduce the practical applications of various measurement concepts.
- To gain knowledge on the design perspective of advanced measuring machines.
- To make the students understand the fundamental principles of measuring techniques by practicing exercises on various measuring instruments.
- To perform metallographic study of the given samples and heat treatment study of steel.
- To familiarize the importance of measurement and inspection in manufacturing industries.

LIST OF EXPERIMENTS:

1. Calibration of comparators using slip gauges
2. Assessment of gauge surfaces using optical flats
3. Measurement of Surface roughness of specimens using contact method
4. Non-contact surface roughness measurement of specimens
5. Counting of fringes produced by Michelson's interferometer
6. Measurement of dimensional features using machine vision system
7. Study exercises on clean room behaviour
8. Roundness and cylindricity measurement of components
9. Study on flatness measurement of surface using autocollimator
10. Measurement of dimensional features of a specimen - Contact type using CMM.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Demonstrate sophisticated measuring machines with ease.

CO2: Improve the confidence in developing of new concepts and new measuring machines.

CO3: Develop various technical terms and perform measurement tasks accurately.

CO4: Indentify the right instrument and method of measurement for a particular Application.

CO5: Apply the fundamental concepts of measurements, standards, calibrations, maintenance of laboratory facilities and handling of equipment's.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2	2	1	2	2
CO2	3	1	1	2	1	2
CO3	2	1	1	2	1	1
CO4	2		1	2	1	3
CO5	3	1	1	3	1	3
Avg	(13/5)=2.6	(5/4)=1.25	(6/5)=1.2	(10/5)=2	(6/5)=1.2	(11/5)=2.2

CM4212 AUTOMATION AND ROBOTICS LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVE:

- To design and test hydraulic, Pneumatic circuits using any compatible software.
- To design and simulate fluid power actuator circuit using software tools.
- To simulate hydraulic and Pneumatic circuits using automation studio/any compatible software.
- To make different types of robots and demonstrate them to identify different robot and for different applications.
- To write robot programming for simple operations.

List of Experiments:

1. System control using PID controllers.
2. Control of actuator using Hydrosim/Phenumsim/ Equivalent software.
3. Design and simulation of two pneumatic circuits using compatible software
4. Design and simulation of two electro-pneumatic circuits using compatible software.
5. Design and simulation of two PLC based circuits (Ladder Diagram) using compatible software.
6. Two PLC based circuit and execute on experiment kit.
7. Robot programming and simulation for shape identification.
8. Robot programming and simulation for any industrial process (Packing, Assembly)
9. Robot programming and simulation for colour identification.
10. Robot programming and simulation for pick and place robot.

Course Outcome:

CO 1: Design and simulate Pneumatic, Electro –Pneumatic and PLC based circuits on compatible software.
CO 2: Model the PLC based circuits on experimental kit.
CO 3: Demonstrate PLC Ladder and robot programming.
CO 4: Evaluate any robotic simulation software to make different types of robot and calculate work volume for different robot.
CO 5: Make use of different types of robots and demonstrate them to identify different parts and components.

List of equipment required:

1. Computer -30 Nos
2. Hydraulic trainer kit with accessories
3. Pneumatic trainer kit accessories
4. PLC interface card
5. Hydraulic/ Pneumatic circuit simulation compatible software
6. Robot operating system
7. Pick and Place robot.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3				3	
CO2	1	1	3			1
CO3	2	3	1	2		2
CO4	3	3	2	1	2	3
CO5	3	2	3	2	1	1
Avg	(12/5)=2.4	(9/4)=2.25	(9/4)=2.25	(5/3)=1.66	(6/3)=2	(7/4)=1.75

CM4311 **PROJECT WORK I** **L T P C**
0 0 12 6

COURSE OBJECTIVES:

- To identify industrial problem and solve them.
- To develop good written and oral communication skills and leadership skills.
- To train the students in preparing the project reports and to face reviews.
- To develop the ability to solve a specific Industrial problem.
- To accelerate the learning process.

EVALUATION

- Project work evaluation is based on Regulations of Credit System University Departments - Postgraduate programmes of Anna University

TOTAL: 180 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:
CO1: Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2: Recognize the importance of literature review.
CO3: Realize the importance of solving problems using literature review.
CO4: Recognize the modern concepts in technology and design.
CO5: Develop skills to read, write and comprehend.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3			3	3	
CO2					3	3
CO3	3		3		3	
CO4					3	3
CO5	3	3				
Avg	(9/3)=3	(3/1)=3	(3/1)=3	(3/1)=3	(12/4)=3	(6/2)=3

CM4411 **PROJECT WORK II** **L T P C**
0 0 24 12

COURSE OBJECTIVES:

- To produce factual results of their applied research idea in the Manufacturing Engineering.
- To improve research and development activities.
- To develop technical competency to provide solutions for problems.
- To accelerate the learning process.
- To develop good communication skills.

EVALUATION

- Project work evaluation is based on Regulations of Credit System University Departments - Postgraduate programmes of Anna University

TOTAL: 360 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:
CO1: Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2: Build strong working knowledge of ethics and professional responsibility.
CO3: Demonstrate effective organizational leadership and change skills.
CO4: Evaluate the importance of solving problems using literature review.
CO5: Develop skills to read, write and comprehend.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3			3	3	
CO2				3	3	
CO3				3	3	3
CO4					3	3
CO5	3	3				
Avg	(6/2)=3	(3/1)=3		(9/3)=3	(12/4)=3	(6/2)=3

CM4001 ADVANCES IN MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To interpret and compare different non-traditional machining processes.
- To recognize different precision machining processes.
- To interpret modern metal forming processes.
- To differentiate between micromachining and microfabrication.
- To formulate smart manufacturing systems.

UNIT I UNCONVENTIONAL MACHINING 9

Introduction - Electrical discharge machining - Micro electrical discharge machining - Wire electrical discharge machining - Micro wire electrical discharge machining - Electro chemical machining - Ultrasonic machining - Plasma arc machining- Laser beam machining- Electron beam machining - Ion beam machining - Abrasive flow machining - Abrasive water jet machining- Comparison of different non-traditional machining processes- Hybrid machining processes.

UNIT II PRECISION MACHINING 9

Introduction - Ductile mode machining of hard and brittle materials - Ultra precision grinding and selection of grinding wheels - Electrolytic in process dressing -Chemical mechanical polishing - Diamond turn machining - High speed machining -Magneto rheological finishing processes.

UNIT III MODERN METAL FORMING 9

Introduction - Orbital forging - Isothermal forging - Rubber pad forming –Incremental forming - Fine blanking -Powder forming: Powder rolling, Powder extrusion - High speed extrusion.

UNIT IV MICRO MACHINING AND MICRO FABRICATION 9

Introduction - Mechanical micro machining - Micromachining tool design - Chip formation - Size effect in micromachining - micro turning, micro milling. Micro drilling- micro machine tools. Introduction to micro fabrication - LIGA, surface micromachining - Bulk micromachining -Etching - Sputtering - Chemical vapor deposition - Physical vapor deposition.

UNIT V INDUSTRY 4.0 9

Introduction - Industry 4.0 – Smart manufacturing: Smart design, smart machining, smart monitoring, smart control, smart scheduling - Internet of Things - Industrial Internet of Things - Framework: Connectivity devices and services - Intelligent networks of manufacturing - Cloud computing - Data analytics -Cyber physical systems -Machine to Machine communication- case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Classify different non-traditional machining processes.
CO2: Identify the different precision machining processes.
CO3: Explain the modern metal forming processes.
CO4: Interpret different micro machining and micro fabrication techniques.
CO5: Demonstrate the Industry 4.0 and smart manufacturing system concepts.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3			3	3	
CO2	3		3	3	3	
CO3	3				3	
CO4	3	3			3	
CO5				3	3	3
Avg	(12/4)=3	(3/1)=3	(3/1)=3	(9/3)=3	(15/5)=3	(3/1)=3

REFERENCES:

1. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.
2. Anand Pandey, “Modern Machining Processes”, Ane Books Pvt. Ltd., New Delhi, 2019.
3. Balasubramaniam R. and Ramagoplan V.S, Sathyan Subbiah, “Diamond Turn Machining”, CRC Press, New York, 2018.
4. Jain V.K., “Introduction to Micromachining”, Narosa, New Delhi, 2014.
5. Kalpakjian S., and Schmid S.R., “Manufacturing Processes for Engineering Materials”,6th edition, Pearson, New Delhi, 2018.
6. Venkatesh V. C. and SudinIzman, “Precision Engineering”, Tata McGraw-Hill, New Delhi, 2007.

CM4002 COMPUTER AIDED PROCESS PLANNING L T P C
3 0 0 3

OBJECTIVES:

- To familiarize the students with the basics of process planning.
- To introduce the part representation methods and approaches
- To acquaint the students with knowledge in process metrics and capabilities
- To gain knowledge on Logical Design of Process Planning
- To impart knowledge on the types of computer aided process planning systems

UNIT I INTRODUCTION: 8

Production Planning and Process Planning -The role of Process Planning in the Manufacturing cycle - Experience based planning -Need for computer aided process planning. –Process Planning and Concurrent Engineering, Group Technology

UNIT II PART DESIGN REPRESENTATION 10

Basic part representation methods: CAD models-Feature based design-Design interface: syntactic pattern recognition-State transition diagram-Decomposition approach-Logic approach-Graph based approach.

UNIT III KNOWLEDGE REPRESENTATION 7

Process knowledge-Dimensions and tolerances- Surface properties-Process constraints-Process economics-Process capability.

UNIT IV SYSTEM FORMULATION 10

Logical Design of Process Planning – System structure-planning strategy-declarative knowledge of part- procedure knowledge of planning-other issues: process parameter selection, tool selection, machine selection, plan optimization , Implementation considerations – Decision table and Decision trees.

UNIT V COMPUTER AIDED PROCESS PLANNING SYSTEMS 10

Computer aided Process Planning – Variant process planning – Generative process planning– Forward and Backward planning, input format - Totally Integrated process planning systems – Expert process planning-Commercial systems: CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course students shall be able to:

CO1: Elaborate on the basics of process planning.
CO2: Demonstrate competency in part representation methods and approaches
CO3: Recognize the importance of process metrics and capabilities
CO4: Elaborate on Logical Design of Process Planning
CO5: To impart knowledge on the types of computer aided process planning systems

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2			
CO2			2			
CO3			2			
CO4			2			
CO5			2			2
Avg			(10/5)=2			(2/1)=2

REFERENCES

1. Chang, T.C. and Wysk, R.A., "An Introduction to automated process planning systems", Prentice Hall, 1985.
2. Chang, T.C., "An Expert Process Planning System", Prentice Hall, 1985.
3. Halevi, G. and Weill, R.D., "Principles of Process Planning", A logical approach – Springer, 2003.
4. Rao., "Computer Aided Manufacturing", Tata McGraw Hill Publishing Co. 2002.
5. Singh, N., "Systems Approach to Computer Integrated Design and Manufacturing", John Wiley & Sons, 1996.
6. Vollmann, T.E. and Bery, W.E., "Manufacturing Planning and Control Systems, 5th Edn., Galgotia Publications, 2004.

CM4003 DESIGN FOR MANUFACTURING L T P C

3 0 0 3

- To impart the knowledge in design for manufacturing and assembly (DFM/A) principles.
- To be acquainted with the use of DFM/A tools.
- To elaborate DFM/A system architecture.
- To outline product model and interfacing.
- To discuss system implementation by considering various manufacturing constraints.

UNIT I INTRODUCTION 9

Implementation of concurrent engineering- Issues involved in introducing design for manufacturing and assembly (DFM/A)-DFM/A principles and techniques - Current state of commercial DFM/A packages- Requirements for a new generation of DFM/A Systems -Knowledge-based approaches to DFM/A- Interfacing design (CAD) and DFM/A Systems, Case studies.

UNIT II DFM/A METHODOLOGIES 9

Total design Environment-Tools: Quality function deployment, Failure modes and effects analysis (FMEA)- Design for manufacturing and assembly principles: Mechanical Assembly-General DFA principles- DFA guidelines: General mechanical, General electro-mechanical - Design for manual assembly- Design for electronics Assembly-Design for Testability-Machining-Currently available manufacturability analysis tools- Integrating DFM/ A into different design regimes - Case studies

UNIT III DFM/A SYSTEM ARCHITECTURE 9

System of system design Scenario --Manufacturing Aspects- Design - Analysis-Methods of data representation- Object-oriented Approach-Databases- Design for Manufacturing-Design for Assembly-Conceptual architecture- Analysis and integration and inference- Interfaces-Analysis engine concepts-Process model- Control and system operation- Control issues.

UNIT IV PRODUCT MODEL AND CAD INTERFACING 9

Product Model - Structure and object - Oriented Approach-Classes and objects - Polymorphism and inheritance - Modelling concepts- Product model structure overview- Detailed product model- Storage of object-Oriented product models - Features in CAD-DFM integration - Feature representation methodologies- Classification of features -Hierarchical structure of the features -Interfacing with different CAD systems - Interface mechanisms for applications-knowledge engineering and inferencing

UNIT V SYSTEM IMPLEMENTATION 9

System for design for PCB assembly, small parts assembly, mechanical assembly, machining Generic architecture operational aspects- Architecture realization- Control module

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the End of the Course, the students will be able to
CO1: Describe the design for manufacturing principles.
CO2: Implement DFM/A principles in the required applications.
CO3: Use DFM/A tools.
CO4: Select appropriate DFM/A system architecture with the given manufacturing aspects.
CO5: Create Product model.

REFERENCES:

1. David M. Anderson, “Design for manufacturability “, CRC Press.,United States, 2014,ISBN 9781482204926.
2. Geoffrey Boothroyd, Peter Dewhurst, and Winston A. Knight, “Product Design, for Manufacture, and Assembly”, 3rd Edition, CRC Press., United States,2011, ISBN 9781420089271.
3. James G. Bralla, “Design for manufacturability handbook”, McGraw Hill., United States, 1999, ISBN-13: 978-0070071391.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3			3		2
CO2	3			3		2
CO3	3			3		2
CO4	3	2		3		2
CO5	3	3		3		2
Avg	**(15/5)=3**	**(5/2)=2.5**		**(15/5)=3**		**(10/5)=2**

CM4004 DESIGN OF CELLULAR MANUFACTURING SYSTEM L T P C

3 0 0 3

OBJECTIVES:

1. To introduce the concept of group technology
2. To expose students to planning and design of cellular manufacturing system
3. To impart knowledge on implementation of group technology/cellular manufacturing systems
4. To outline the concept of performance measurement and control of GT/CMS
5. To gain knowledge on economics of GT/CMS

UNIT I INTRODUCTION: 12

Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

UNIT II CMS PLANNING AND DESIGN: 10

Problems in GT/CMS - Design of CMS - Models, traditional approaches and non-traditional approaches - Genetic Algorithms, Simulated Annealing, Neural networks.

UNIT III IMPLEMENTATION OF GT/CMS: 10

Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

UNIT IV PERFORMANCE MEASUREMENT AND CONTROL: 8

Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

UNIT V ECONOMICS OF GT/CMS: 5

Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students shall be able to

CO1: Perceive the concept of group technology

CO2: Understand the planning and design of CMS

CO3: Gain knowledge on implementation of GT/CMS

CO4: Analyse the performance measurement and control of GT/CMS

CO5: Describe the economics of GT/CMS

REFERENCES

1. Burbidge, J.L., “Group Technology in Engineering Industry", Mechanical Engineering pub.London, 1979.
2. Cleland.D.I. and Bidananda, B. (Eds), "The automated factory handbook: technology and management”, TAB Books , NY, 1991.
3. Irani, S.A., " Hand Book of Cellular Manufacturing Systems", John Wiley & Sons, 1999
4. Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds), "Planning, design and analysis of cellular manufacturing systems", Elsevier, 1995.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1		3	1		
2	1		3	2		
3	1		3	3		
4	1		3	2		
5	1		3	1		
Avg	**(5/5)=1**		**(15/5)=3**	**(9/5)=1.8**		

CM4005 FINITE ELEMENT ANALYSIS IN MANUFACTURING ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To equip students with fundamentals of finite element principles.
- To impart knowledge on solving 2 dimensional finite element problems.
- To develop finite element model for the field problems.
- To introduce non-linear analysis and its computational methods.
- To emphasis on the finite element approach of production processes.

UNIT I GENERAL INTRODUCTION 10

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems –Variational Formulation of Boundary Value Problems – Ritz Technique –Natural and Essential Boundary conditions - Basic concepts of the Finite Element Method. One Dimensional Second Order Equations – Discretization – element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors - Assembly of Matrices - solution of problems from solid - Structural, stress, and strain analysis – Introduction to beam elements.

UNIT II PROBLEM IN 2D: 9

Second Order 2D Equations involving Scalar& Vector Variables – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems in Manufacturing Engineering - Quadrilateral elements. Introduction to elasticity equations – stress strain relations – plane problems of elasticity – element equations Plane stress, plane strain and axisymmetric problems – stress-strain-time or constitutive equations- Introduction to flow problems- solution of problems in fluid mechanics- numerical examples -plates and shell

UNIT III APPLICATIONS TO FIELD PROBLEMS 9

Higher Order Elements. Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One, two and three dimensions – Serendipity elements – Numerical integration and application to plane stress problems transformation in $\xi, \eta \, and \, \zeta -$ coordinates- Jacobian of transformation-order of convergence- numerical integration –example problems- shape functions in natural coordinates- rectangular elements- Lagrange family- Serendipity family- rectangular prisms- tetrahedral elements

UNIT IV NON-LINEAR ANALYSIS 9

Introduction to Non-linear problems - some solution techniques- computational procedure- simple material nonlinearity- Plasticity and viscoplasticity, stress stiffening, contact interfaces- problems of gaps and contact- geometric non-linearity- modeling considerations- Impact analysis.

UNIT V ANALYSIS OF PRODUCTION PROCESSES 8

Application to Bulk forming, sheet metal forming, casting, metal cutting, welding- Features of software packages

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Demonstrate finite element analysis techniques
CO2: Solve 2 dimensional finite element problems.
CO3: Analyze of field problems for shape function
CO4: Determine the computational solution techniques for non linear problems
CO5: Apply finite element analysis techniques to analyse the production processes

REFERENCES

1. Bathe, K.J., “Finite Element Procedures in Engineering Analysis, 1990.
2. Kobayashi, S., Soo-IK-Oh and Altan, T., “Metal forming and the Finite element Methods”, Oxford University Press, 1989.
3. Lewis, R.W., Morgan, K, Thomas, H.R., and Seetharaman, K.N., “The Finite Element Method in Heat Transfer Analysis”, John Wiley, 1994.
4. Rao, “Finite Element Method in Engineering”, Pergammon Press, 2005.
5. Reddy, J.N, “An Introduction to the Finite element Method”, McGraw – Hill, 2005.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1			1	
CO2	2	1			1	
CO3	2	1			1	
CO4	2	1			1	
CO5	2	1	2		1	
Avg	**(10/5)=2**	**(5/5)=1**	**(2/1)=2**		**(5/5)=1**	

CM4006 ADVANCES IN WELDING AND CASTING TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on Metallurgy of welding.
- To be acquainted with Special welding processes.
- To elaborate gating system design and metallurgy.
- To provide knowledge on Special casting processes.
- To familiarize the students with automation and environmental aspects of welding and casting.

UNIT I WELDING DESIGN 9

Introduction - Fusion zone – Heat flow in welding -Weld solidification --Weldability of steels – Cast iron - Stainless steels, aluminum, copper and titanium alloys - Pre and Post weld heat treatments - Weld joint design- residual stress - Testing of Welding joints -Weld defects – Case study on welding design.

UNIT II SPECIAL WELDING PROCESSES 9

Principles, Equipment, Types, Advantages and Limitations of High frequency induction welding, Diffusion bonding, Cold pressure welding, Friction welding, Explosive welding, Plasma arc welding, Ultrasonic welding, Electron beam welding and Laser beam welding.

UNIT III CASTING DESIGN 9

Introduction - Solidification shrinkage- - Pattern allowances- Design of gating System-Design of thin and unequal sections -Rapid solidification processing (RSP) - Melt spinning -Roll quenching - Vibratory solidification -Splat cooling - Thixoforming – Rheocasting - Single crystal growing Casting defects, inspection, diagnosis and rectification – Case study on casting design.

UNIT IV SPECIAL CASTING PROCESSES 9

Evaporative Pattern Casting Process and full mould process – Vaccum sealed moulding – vacuum casting - Magnetic Moulding - Squeeze Casting-types - Plaster mould casting - Ceramic mould casting- Investment casting - Shell Moulding - Continuous casting - Electro slag casting.

UNIT V AUTOMATION AND ENVIRONMENTAL ASPECTS OF WELDING AND CASTING 9

Mechanization and automation in foundries: Sand Plant, Material Handling, Mould and Core Making- Pollution control, energy and waste management in foundries. Automated welded joint- Welding robots, Positioners and Manipulators -Microprocessor based control of resistance and arc welding- Arc sensing, Weld Seam Tracking and Vision system - Effects of welding fumes on environment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Use design knowledge to overcome defects in welding.
CO2: Select suitable welding process for the given applications.
CO3: Use design knowledge to produce quality casting.
CO4: Select suitable casting process for the given applications.

CO5: Implement automation principles with environment consciousness techniques in welding and casting plants

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3					1
CO2	2					
CO3	3					1
CO4	2					
CO5	2				2	
Avg	(12/5)=2.4				(2/1)=2	(2/2)=1

REFERENCES:

1. American Welding Society,"Welding Handbook", Volume 1-5, 9th Edition, 2001.
2. Dieter Radaj, "Design and Analysis of Fatigue Resistant Welded Structures", Woodhead Publishing, United Kingdom, 1990, ISBN: 978-1855730045.
3. John Campbell, "Complete Casting Handbook: Metal Casting Processes, Metallurgy, Techniques and Design", 2nd edition, Butterworth-Heinemann., United Kingdom, 2015, ISBN: 978-1856178099.
4. Mahi Sahoo and Sam Sahu, "Principles of Metal Casting", McGraw-Hill Education, United States, 3 rd Edition, 2014, ISBN: 978-0071789752.
5. Robert B. Tuttle, "Foundry Engineering: The Metallurgy and Design of Castings", Create Space Independent Publishing Platform, Amazon, 2012, ISBN: 9781478157434.

CM4007 **PRECISION ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To gain knowledge of the need for precision engineering and its application.
- To familiarize the importance of materials in precision engineering.
- To Introduce latest topics in manufacturing like micro machining and MEMS in order to equip them to join core facturing industries.
- To Impart knowledge about the causes of errors and their remedies.
- To introduce the students with elements used in precision machines.

UNIT I INTRODUCTION **9**

Accuracy and Precision– Need for high precision –concept of accuracy - tolerance and fits system – Hole and shaft system – accuracy of manufacturing processes – types of fits – Selective assembly.

UNIT II MATERIALS FOR PRECISION ENGINEERING **9**

Diamond - types-single crystal - PCD - Natural-synthetic CBN - Ceramics - coated metals and non-metals - High performance polymer - alloys - refractory metals: cutting tools – performance - components of instruments - Jewels - self Lubrication - smart materials - properties - testing - applications.

UNIT III PRECISION MACHINING **9**

Precision grinding: IC chip manufacturing- ELID process - aspherical surface generation Grinding wheel- Designer and selection of grinding wheel -High-speed grinding -High-speed milling -Micro machining - Diamond turning-MEMS - micro finishing process – surface roughness measures - concept and non-concept method - comparison of features with machining process.

UNIT IV ERRORS: CAUSES AND REMEDIES 9

Static stiffness - influence on machining accuracy - over all stiffness in a machine/instrument - errors due to variation of cutting forces - clamping forces - errors due to compliance while machining. Inaccuracy due to thermal effects: Heat sources and dissipation - Geometry of thermal deformation – Influence of forced is statics dimensional wear of elements - instruments; Machining tools and their influence on accuracy- error due to clamping and setting location.

UNIT V PRECISION MACHINE ELEMENTS 9

Introduction- guide ways- Drive systems; rolling element bearings - Principles, construction, classification, application etc., - Lubricated sliding bearings - construction - Principles etc., - Hydrostatics bearings-types - aerostatic bearings - linear drive motors - magnetic bearings - applications - limitations - advantages.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Understand the need of precision engineering and its application.
CO2: Discuss process knowledge to use the light material / superior material as per the raising demands.
CO3: Discuss the advanced precision machining processes.
CO4: Explain the various errors, its causes and remedies to overcome these.
CO5: Describe elements used in precision machine tool.

REFERENCES:

1. James D. and Meadow, S., “Geometric Dimensioning and Tolerancing”, Marcel Dekker Inc.,1995.
2. Juliar W.Gardner, and Vijay K. Varadan, “Micro Sensors, MEMS and Smart Devices”, John Wiley and Sons, 2001.
3. Murthy R.L., “Precision Engineering in Manufacturing”, New age International Publications, New Delhi, First edition 1996; Reprint 2005.
4. Paulo Davim "Microfabrication and Precision Engineering: Research and Development", Woodhead publishing, 2017.
5. Venkatesh V.C. and Sudin I., “Precision engineering”, Tata McGraw Hill Co., New Delhi, 2007.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3		2	1		1
CO2	3	1	1	1	1	2
CO3	3		2	2		1
CO4	3	1	2	3	2	2
CO5	3		3	2	1	1
Avg	(15/5)=3	(2/2)=1	(10/5)=2	(9/5)=1.8	(4/3)=1.33	(7/5)=1.4

MF4091 MANUFACTURING MANAGEMENT L T P C
3 0 0 3

OBJECTIVES

1. Students will be able to study the concepts in facility planning.
2. Students will be able to study types of plant layout and capacity planning methods.
3. Students will be able to study the concepts of Project management.
4. Students will be able to study the concepts and methods in production planning and control.
5. Students will be able to study the concepts in Inventory and maintenance management.

UNIT-I FACILITY PLANNING 9

Facility planning – Factors affecting selection of plant location, Factor rating analysis: Break – even analysis, Load distance model, closeness ratings – case study

UNIT-II CAPACITY & LAYOUT PLANNING 9

Types of plant layout, criteria for good layout, Process layout, Assembly line balancing. Computer based solutions to layout problems such as CRAFT, ALDEP, CORELAP and PREP. Capacity planning – Analysis of designed capacity, installed capacity, commissioned capacity, utilized capacity, factors affecting productivity and capacity expansion strategies.

UNIT-III PROJECT MANAGEMENT 9

Demand forecasting – Quantitative and qualitative techniques, measurement of forecasting errors, Project management – its role in functional areas of management, network representation of a project, CPM and PERT techniques – case study

UNIT-IV PRODUCTION PLANNING & CONTROL 9

Aggregate production planning, production planning strategies, Disaggregating the aggregate plan, Materials Requirement Planning (MRP), MRP-II, Supply chain management, Operation scheduling, prioritization.

UNIT-V INVENTORY AND MAINTENANCE MANAGEMENT 9

Introduction to EOQ models, Inventory control techniques – ABC, FSN, VED etc. Types of inventory control – Perpetual, two-bin and periodic inventory system – JIT, SMED, Kanban, Zero inventory, Maintenance strategies and planning, Maintenance economics: quantitative analysis, optimal number of machines, Replacement strategies and policies – economic service life, opportunity cost, replacement analysis using specific time period.

TOTAL =45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

1. Able to acquire knowledge on facility, and problems associated with it.
2. Ability to learn the various capacity and layout planning models
3. Understand the concepts of demand forecasting and project management with relevant case studies.
4. Able to understand the concepts of production planning and scheduling.
5. Understand the various inventory and maintenance management techniques.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1			1	
CO2	2	1			1	
CO3	2	1			1	
CO4	2	1				
CO5	2	1				
Avg	(10/5)=2	(5/5)=1			(3/3)=1	

REFERENCES:

1. Chary, SN, “Production and Operations Management”, 4th Edition, SIE, TMH, 2009.
2. Chase. RB, N. J. Aquilano, & F. R. Jacobs, “Operations Management – For Competitive Advantage”, 11th Edition, SIE, TMH, 2007.
3. James. B. Dilworth, “Operations Management – Design, Planning and Control for Manufacturing and Services”, McGraw Hill Inc. Management Series, 1992.
4. KanishkaBedi, “Production and Operations Management”, 2 nd Edition, Oxford Higher Education, 2007
5. Lee. J. Krajewski, L. P. Ritzman, & M. K. Malhothra, “Operations Management – Process and Value Chains”, 8th Edition, PHI/Pearson Education, 2007.
6. MelnykDenzler, “Operations Management – A Value Driven Approach”, Irwin McGraw Hill , 1996.
7. Pannererselvam, R “Production and Operations Management”, 3rd Edition, PHI, 2012.

CM4008 **APPLIED MATERIALS ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge in the areas of elastic and plastic behavior of materials.
- To understand the fracture behavior of materials.
- To elaborate the theories on plastic forming.
- To classify the different types of advanced materials.
- To select the material for specific industrial applications

UNIT I ELASTIC AND PLASTIC BEHAVIOUR 9

Elastic, plastic and elastic and viscoelastic Behavior-Mechanism of Elastic and Plastic deformation, Shear strength of perfect and real crystals - Deformation by slip and twinning, strengthening mechanism, solid solution, grain boundary, poly phase mixture, precipitation, particle, fibre and dispersion strengthening, work hardening - Effect of temperature, strain and strain rate on plastic behavior.

UNIT II FRACTURE BEHAVIOUR 9

Types of fracture -Griffith's theory, dislocation theory, ductile to brittle transition in steel – Stress intensity factor, fracture toughness and toughening mechanisms -High temperature fracture, creep - Larson-Miller Parameter - Deformation and fracture mechanism maps - Fatigue. Low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law, Effect of surface and metallurgical parameters on fatigue failure.

UNIT III PLASTIC FORMING OF METALS 9

Fundamentals of metal working, mechanics of metal working, flow-stress distribution, residual stresses, temperature in metal working- Forging in plane strain, open and closed die forging - Forces and geometrical relationships in rolling, theories of cold and hot rolling, bending and stretch forming.

UNIT IV ADVANCED MATERIALS 9

Dual phase steels, high strength low alloy steel, transformation induced plasticity steel, Maraging steel, smart materials, properties and applications of engineering plastics and composites materials - advanced structural ceramics -WC, TiC, TaC, Al2O3, SiC, Si3N4, CBN, and Diamond - Functionally gradient materials, Nano materials.

UNIT V SELECTION OF MATERIALS AND TESTING 9

Motivation, cost basis and service requirements - Selection for mechanical properties, Selection for surface durability - Relationship between materials processing and selection - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Forgeability and castability test- NDT techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Discuss elastic plastic behavior of metals and its strengthening mechanisms.
CO2: Analyse the fracture behavior of metals and give solutions to avoid them.
CO3: Create processing techniques for controlling shape of the final product.
CO4: Select suitable materials for the specific industrial applications.
CO5: Able to work in R&D activity in the field of material science.

REFERENCES:

1. ASM Handbook Volume 02: "Properties and Selection: Nonferrous Alloys and Special-Purpose Materials", ASM international,10th edition, 1990.
2. ASM hand book, volume 11, "Failure Analysis and Prevention", ASM international,10th edition, 2002.
3. Burakonsa T.Z., and Wierzchan.T., "Surface Engineering of Materials"- Principles of Equipment, Techniques, CRC press, 1st edition 1998.
4. Crane F.A.A., Charles J.A., and Furness, J.A.G., "Selection and use of engineering Materials", Reed Elsevier India, 2006.

5. Courtney T.H., “Mechanical Behaviour of Materials”, 2nd edition, McGraw Hill, 2017.
6. Dieter G.E., “Mechanical Metallurgy”, McGraw Hill education, 3rd edition, 2017.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	3			1	2
CO2	3	3			1	1
CO3	2	2		2	2	1
CO4	2				1	
CO5	3	3			2	1
Avg	(13/5)=2.6	(11/4)=2.75		(2/1)=2	(7/5)=1.4	(5/4)=1.25

CM4009 MICRO AND NANO MANUFACTURING L T P C
3 0 0 3

OBJECTIVES:

- To introduce Meso, Micro and Nano manufacturing and their respective applications.
- To familiarize the students with diamond, turn machining.
- To acquaint the students with advanced micro machining and nano finishing methods.
- To familiarize the students with synthesis of nanomaterials.
- To gain knowledge on the types of characterization techniques to be used.

UNIT I INTRODUCTION 9

Introduction to Meso, Micro and Nano manufacturing, Miniaturization and applications, classification-subtractive, additive, micro casting, micro forming, micro joining.
Micro and Nano products

UNIT II MANUFACTURING METHODS 9

Material deposition – PVD, CVD, LIGA, Micro stereo lithography, Electro discharge deposition, Traditional micromachining- Theory of micromachining-Chip formation-size effect in micromachining, micro turning, micro drilling, micro milling, micro grinding, Diamond turn machining

UNIT III ADVANCED MACHINING / FINISHING PROCESSES 9

Introduction to mechanical and beam energy based micro machining processes- Ultrasonic micro machining, Focused Ion Beam machining, Laser Beam micro machining , Micro/ Nano finishing processes- Abrasive Flow Machining, Magnetic Abrasive Finishing, Magneto Rheological Abrasive Flow Machining, Magneto Rheological Finishing. Hybrid micro/nano machining – Electro Chemical Spark Micro Machining, Electro Discharge Grinding, Electrolytic In Process Dressing Grinding

UNIT IV SYNTHESIS OF NANOMATERIALS 9

Introduction to nano materials, Methods of production of Nanoparticles, Sol-gel synthesis, Inert gas condensation, High energy Ball milling, Plasma synthesis, Electro deposition and other techniques. Synthesis of Carbon Nanotubes – Solid carbon source based production techniques, Gaseous carbon source based production techniques – Diamond Like Carbon coating. Nano wires

UNIT V CHARACTERISATION TECHNIQUES 9

Metrology for micro machined components-Optical Microscopy,White Light Interferrometry, Molecular Measuring Machine, Micro CMM Scanning Probe Microscopy (SPM) – Scanning Electron Microscope, Transmission Electron Microscope, Scanning Thermal Microscopy, Tribological characteristics -Micro abrasion wear -Nano indentation- Ellipsometric Analysis

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Explain micro and nano manufacturing methods**.**
CO2: Extend material deposition methods for manufacturing
CO3: Select advanced machining process
CO4: Build nano composite materials
CO5: Analyze the nano materials and characterization techniques

REFERENCES

1. Bandyopadhyay, A.K., "Nano Materials", New Age International Publishers, New Delhi, SBN 8122422578, 2008.
2. Bhushan, B., "Handbook of Nanotechnology", Springer, Germany, ISBN-10: 3642025242, 2010.
3. Jain, V.K "Introduction to Micromachining", First edition,Narosa publishing house, ISBN: 9781138076426, 2017.
4. Jain, V.K, "Micro manufacturing Processes", by CRC Press, ISBN: 9781439852903, 2012.
5. McGeough, J.A. Micromachining of Engineering Materials **,** CRC Press, ISBN-10: 0824706447, 2001.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1			2	1		
CO2	2		3	1		
CO3			3	1		
CO4			2	1		
CO5			3	1		
Avg	(2/1)=2		(13/5)=2.6	(5/5)=1		

IL4093 SUPPLY CHAIN MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- Explain the role of supply chain management in an organization.
- Identify the various aspects of supply chain management and the factors affecting
- them.
- Explain the relationship among various factors involved in planning, organising and controlling supply chain operations.
- Summarize the sourcing and inventory decisions involved in supply chain operations.
- Explain the use of information technology in supply chain management.

UNIT I INTRODUCTION SUPPLY CHAIN MANAGEMENT 9

Introduction, Types of supply chains with and examples, Evolution of SCM concepts, Supply chain performance, Strategic Fit, Drivers of Supply Chain Performance – key decision areas – External Drivers of Change. Supply contracts – centralized vs. decentralized system

UNIT II SUPPLY CHAIN NETWORK DESIGN 9

Need for distribution network design- Factors affecting, Design options for distribution network. Network design decisions - Framework, factors influencing, Models of facility location and capacity allocation. Role of Transportation in supply chain, modes of transportation Modal Selection, Classification of carriers, Carrier Selection, Transportation Execution and Control. Food Mile Concept., design options.

UNIT III DEMAND AND SUPPLY IN SUPPLY CHAIN 9

Forecasting in supply chain- Methods, Approach, Errors.Aggregate planning in supply chain- Problem, Strategies and Implementation. Predictable variability in supply chain, Managing supply and demand.

Distribution strategies-direct shipment, traditional warehousing, cross docking, inventory pooling, transhipment, Choosing appropriate strategy, Milk Run Model.

UNIT IV SOURCING AND INVENTORY DECISIONS IN SUPPLY CHAIN 9

Purchasing Vs Procurement Vs Strategic Sourcing, Item procurement importance matrix, Strategic Sourcing Methodology, Managing sourcing and procurement process, Supplier selection and evaluation, Bullwhip effect and its management, Economies of scale in supply chain- Cycle inventory, Estimation, Quantity discounts, Multiechelon cycle inventory. Uncertainty in supply chain- Safety inventory, Determination of appropriate level, Impact on uncertainity.

UNIT V SUPPLYCHAIN AND INFORMATION SYSTEMS 9

Information in supply chain, Role of Information technology, IT framework in supply chain, Supplier and Customer relationship management. Role of e-business in supply chain, e-sourcing and e-procurement. Technology drivers in supply chain - Risk management.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: To introduce the concepts and elements of supply chain management.
CO2: to understand supply chain network design aspects for various manufacturing and service sectors.
CO3: To understand the principle of demand and supply in supply chain
CO4: To gain knowledge on the sourcing and inventory decisions in supply chain.
CO5: To understand the concepts of supply chain information systems.

REFERENCES

1. Chopra S. and Meihdl P., “Supply Chain Management- Strategy, Planning and Operations”, Pearson Education Asia. 2007.
2. Dougart L., Stock J. and Ellram L., “Logistic Management”, Irwin McGraw Hill International Edition" 1998.
3. Kaminsky S., “Design and Managing the Supply chain” , McGraw Hill International Edition. 2000.
4. Raghuram G, and N.Rangaraj, “Logistics and Supply Chain Management -cases and concepts”, McMilan India Pvt Ltd, New Delhi,. 2000.
5. Sahay B.S. “Supply Chain Management: For Global Competitiveness”, 2nd Edition, Macmillan, India Ltd, 2011.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	2	-
CO4	-	-	-	-	-	-
CO5	2	-	-	-	-	-
Avg.	(1+2)/2=1.5	-	-	-	2/1=2	-

1 - low, 2-medium, 3-high, ‘-“- no correlation

IL4075 LEAN MANUFACTURING AND SIX SIGMA L T P C
3 0 0 3

OBJECTIVES:

- Summarize the basics of Lean and Six Sigma.
- Describe the need and the process of integrating Lean and Six sigma.
- Identify and select the resources required for LSS Projects and selection of projects including Team building.
- Infer the DMAIC process and study the various tools for undertaking LSS projects.
- Relate how to institutionalize the LSS efforts.

UNIT I INTRODUCTION TO LEAN AND SIX SIGMA 9

Introduction to Lean- Definition, Purpose, Features of Lean ; Top seven wastes, Need for Lean management, The philosophy of lean management, Creating a lean enterprise, Elements of Lean, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma, origin of six sigma, Six sigma concept and Critical success factors for six sigma; Case analysis.

UNIT II INTEGRATION OF LEAN AND SIX SIGMA 9

Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma. The laws of lean six sigma, Key elements of LSS, the LSS model and the benefits of lean six sigma. Initiation - Top management commitment – Infrastructure and deployment planning, Process focus, organizational structures, Measures – Rewards and recognition, Infrastructure tools, structure of transforming event and Launch preparation; Case study presentations.

UNIT III PROJECT SELECTION AND TEAM BUILDING 9

Resource and project selection, Selection of Champions, Identification of potential projects, top down (Balanced score card) and Bottom up approach – Methods of selecting projects – Benefit/Effort graph, Process mapping, value stream mapping, Predicting and improving team performance, Nine team roles and Team leadership; Case study presentations .Black belts, Training of Black belts

UNIT IV THE DMAIC PROCESS AND TOOLS 9

The DMAIC process – Toll gate reviews; The DMAIC tools; Define tools – Project definition form, SIPOC diagram; Measure tools – Process mapping, Lead time/cycle time, Pareto chart, Cause and Effect matrix, FMEA; Idea – generating and organizing tools – Brainstorming, Nominal group technique, Multi-voting and Cause and effect diagram, Data collection and accuracy tools- Check sheet, Gauge R&R; Understanding and eliminating variation- run charts, control charts and process capability analysis; Analyze tools - Scatter plots, ANOVA, Regression analysis, Time trap analysis; Improve tools – Mistake proofing, Kaizen, set up time reduction (SMED), TPM, DOE and the pull system. Control tools – statistical process control.

UNIT V INSTITUTIONALIZING AND DESIGN FOR LSS 9

Institutionalizing lean six sigma – improving design velocity, creating cycle time base line, valuing projects, gating the projects, reducing product line complexity, Design for lean six sigma, QFD, Theory of Inventive Problem solving (TRIZ), Robust design; Case study presentations.

TOTAL:45 PERIODS

OUTCOMES:

CO1: The students will be able to understand what is Lean and Six sigma and their importance in the globalised competitive world.

CO2: The students will be able to understand the importance of integrating Lean and Six sigma and also the process of their integration.

CO3: The students will be able to plan the Resources required to undertake the LSS projects and also acquire how to select the suitable projects and the teams.

CO4: The students will be able apply DMAIC methodology to execute LSS projects and in this regard they will be acquainted with various LSS tools.

CO5: The students will be able to understand the process of institutionalizing the LSS effort and also understand the Design for LSS.

REFERENCES:

1. James P. Womack, Daniel T. Jones, Lean Thinking, Free press business, 2003.
2. Michael L. George, Lean Six Sigma, McGraw-Hill., 2002.
3. Ronald G.Askin and Jeffrey B.Goldberg, Design and Analysis of Lean Production Systems, John Wiley &Sons., 2003.
4. Salman Taghizadegan, Essentials of Lean Six Sigma, Elsevier, 2010.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-	-
CO2	1	-	-	-	-	-
CO3	-	-	-	1	-	-
CO4	-	-	1	-	-	-
CO5	-	-	-	-	-	-
Avg.	(1+1)/2=1	-	1/1=1	1/1=1	-	-

1 - low, 2-medium, 3-high, '-"- no correlation

IL4071 ADVANCED OPTIMIZATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- Learn to solve integer programming problems
- To know how to solve the Dynamic programming problems
- Learn to solve non – linear programming problems with un constrained optimization problems
- Understand to solve non-linear programming problems using KKT conditions, quadratic and separable programming
- To create awareness of Meta heuristic algorithms.

UNIT I INTEGER PROGRAMMING 9

Branch and Bound technique –cutting plane algorithm method - Travelling Salesman problem -Traveling Salesman Problem - Branch and Bound Algorithms for TSP - Heuristics for TSP - Chinese Postman Problem - Vehicle Routeing Problem

UNIT II DYNAMIC PROGRAMMING 9

Characteristics of Dynamic Programming Problems - Deterministic Dynamic Programming - Forward and Backward recursive recursion – selected dynamic programming application – investment model – inventory model – replacement model –reliability model – stage coach problem.

UNIT III NONLINEAR PROGRAMMING - I 9

Types of Nonlinear Programming Problems - One-Variable Unconstrained Optimization - Multivariable Unconstrained Optimization

UNIT IV NONLINEAR PROGRAMMING – II 9

The Karush-Kuhn-Tucker (KKT) Conditions for Constrained Optimization - Quadratic Programming - Separable Programming - Convex Programming - Nonconvex Programming

UNIT V NON-TRADITIONAL OPTIMIZATION 9

Overview of Genetic algorithms, Simulated Annealing, neural network based optimization. Particle Swarm optimization, Ant Colony Optimization, Optimization of Fuzzy Systems.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Know how to solve integer programming problems
CO2: Able to solve Dynamic programming problems
CO3: Familiar in solving unconstrained non linear optimization problems
CO4: Familiar in solving constrained liner optimization problems
CO5: Know how to solve non linear optimization problems using Meta heuristic algorithms

REFERENCES:

1. Fredrick S.Hillier and G.J.Liberman, “Introduction to Operations Research”, McGraw Hill Inc. 1995.
2. Kalymanoy Deb, “Optimization for Engineering Design”,PHI,2003
3. Christos H. Papadimitriou, Kenneth Steiglitz, Combinatorial Optimization, PHI 2006
4. Ravindran – Phillips –Solberg, “Operations Research – Principles and Practice”, John Wiley India, 2006.
5. Singiresu.S.Rao, “Engineering optimization – Theory and practices”, John Wiley and Sons, 1996.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-	-	-
CO2	-	1	-	-	-	-
CO3	-	1	-	-	-	-
CO4	-	1	-	-	-	-
CO5	-	1	-	-	-	-
Avg.	2/1=2	(1+1+1+1)/4=1	-	-	-	-

1 - low, 2-medium, 3-high, ‘-“- no correlation

CM4010 MACHINE LEARNING L TP C
3 0 03

COURSE OBJECTIVES:

This course will make students

1. To learn the basic aspects of machine learning.
2. To get basic knowledge on supervised learning.
3. To realize the importance of unsupervised learning.
4. To exposed on direct and indirect neuro control schemes.
5. To get insight into the basic knowledge on fuzzy logic systems

UNIT-I INTRODUCTION TO MACHINE LEARNING 9

Course objectives of machine learning – Human learning/ Machine learning – Types of Machine learning:- Supervised Learning – Unsupervised learning – Reinforcement Learning – Evolutionary Learning - Regression – Classification – The Machine Learning Process:- Data Collection and Preparation – Feature Selection – Algorithm Choice – Parameter and Model Selection – Training – Evaluation

UNIT-II SUPERVISED LEARNING 9

Linearly separable and nonlinearly separable populations – Introduction to ANN: Biological neuron, artificial neuron, activation function, Perceptron,Multi Layer Perceptron–Backpropagation Learning Algorithm – Radial Basis Function Network – Support Vector Machines: - Kernels – Risk and Loss Functions - Support Vector Machine Algorithm –Multi Class Classification – Support Vector Regression

UNIT-III UNSUPERVISED LEARNING 9

Introduction – Clustering:-Partitioning Methods:- K-means algorithm - Hierarchical clustering –Fuzzy Clustering – Clustering High-Dimensional Data:- Problems – Challenges – Subspace Clustering – Biclustering- Self Organizing Map (SOM) - SOM algorithm

UNIT-IV NEURAL NETWORKS FOR MODELING AND CONTROL 9

Need for using ANN in Modeling and Control – Modeling of non-linear systems using ANN:Generation of training data, Identification of Optimal architecture, Model validation – Control of nonlinearsystems using ANN: Direct and Indirect neuro control schemes – Adaptive neuro controller

UNIT-V FUZZY LOGIC SYSTEMS 9

Fuzzy set theory – Operation on fuzzy sets: Scalar cardinality, Fuzzy cardinality, Fuzzy union and intersection, Fuzzy complement (Yager and Sugeno), Aggregation, Projection, Composition, Cylindrical extension, Fuzzy relation – Fuzzy membership functions - Modeling of non-linear systems using fuzzy models: Fuzzification, Knowledge base, Decision making logic, Defuzzification.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will be able

CO1: To get familiarize with the basic aspects of machine learning.
CO2: To get exposure on supervised and unsupervised learning.
CO3: To demonstrate the need for neutral networks for modelling and control
CO4: To get familiarize with the fuzzy logic systems.
CO5: To realize the importance of machine learning and its applications.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓		
CO2	✓	✓	✓		✓	✓
CO3	✓	✓	✓	✓		
CO4	✓	✓	✓		✓	✓
CO5	✓	✓	✓	✓	✓	✓

REFERENCES:

1. EthemAlpydin, “Introduction to Machine learning (Adaptive Computation and MachineLearning series)”, MIT Press, 2004.
2. Ferdinand van der Heijden, Robert Duin, Dick de Ridder, David M. J. Tax, Classification, Parameter Estimation, and State Estimation: An Engineering Approach Using MATLAB, John Wiley & Sons, 2005.
3. Klir GJ, and Bo, Yuan, “Fuzzy sets and fuzzy logic, Theory and applications”, Prentice Hall, 1995.
4. Millon WT, Sutton RS and Webrose PJ, “Neural Networks for Control”, MIT press, 1992.

CM4072 ELECTRONICS MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on wafer preparation and PCB fabrication
- To introduce Through Hole Technology (THT) and Surface Mount Technology (SMT) with various types of electronic components
- To elaborate various steps in Surface Mount Technology (SMT)
- To be acquainted with various testing and inspection methods of populated PCBS
- To outline repair, rework and quality aspects of Electronic assemblies.

UNIT I INTRODUCTION TO ELECTRONICS MANUFACTURING 9

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed Circuit Boards, types- single sided, double sided, multi layer and flexible printed circuit board, design, materials, manufacturing, inspection. Electronic packaging – Through Hole Technology (THT) and Surface Mount Technology (SMT)

UNIT II COMPONENTS AND PACKAGING 8

Through-hole components – axial, radial, multi leaded, odd form. Surface mount components- active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, Flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

UNIT III SOLDERING AND CLEANING 9

Soldering theory, effect of elemental constituents on wetting, microstructure and soldering, solder paste technology – fluxing reactions, flux chemistry, solder powder, solder paste composition and

manufacturing, solder paste rheology, Wave soldering. Adhesive and solder paste application. solder system variables. soldering temperature profile. Reflow soldering - profile generation and control, soldering quality and defects. Post solder cleaning and selection. Measurement of cleanliness levels.

UNIT IV SURFACE MOUNT TECHNOLOGY: 9

SMT Equipment and Material Handling Systems, Handling of Components and Assemblies - Moisture Sensitivity and ESD, Safety and Precautions Needed, IPC and Other Standards, Stencil Printing Process, solder paste storage and handling, stencils and squeegees, process parameters, quality control - Component Placement, Equipment Type, Chip shooter, IC placer, Flexibility, Accuracy of Placement, Throughput, reflow soldering, adhesive, underfill and encapsulation process, applications, storage and handling, process & parameters.

UNIT V INSPECTION, TEST AND REWORK FOR PCB: 9

Inspection Techniques, Equipment and Principle – AOI, X-ray. stencil printing process- defects & corrective action, component placement process - defects & corrective action, Reflow Soldering Process- defects & corrective action, underfill and encapsulation Process- defects & corrective action, Testing of assemblies, In-circuit testing (ICT), functional testing, concept of yield, Rework and Repair, tools, rework criteria and process, Design for - Manufacturability, Assembly, Reworkability, Testing, Reliability and Environment.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Realize wafer preparation and PCB fabrication.

CO2: Elaborate on through hole and surface mount technology components.

CO3: Discuss the steps involved in soldering post solder cleaning and its importance in PCB manufacturing.

CO4: Improve knowledge on surface mount technology.

CO5: Locate the required inspections, testing and repair methods used in PCB.

REFERENCES

1. Coombs, Jr. C.E., " Printed Circuits Handbook " Mc Graw-Hill Hand books Sixth Edition, 2008
2. Gurnett, K.W., "Surface Mount Handbook", Newnes Elsevier , 1999
3. Landers, T.L., "Electronics Manufacturing Processes", Prentice Hall, 1998
4. Lee, N.C., "Reflow Soldering Process and Trouble Shooting – SMT, BGA, CSP and Flip Chip Technologies", Newnes Elsevier, 2001
5. Prasad R.P., "Surface Mount Technology: Principles and Practice", New York: Chapman and Hall, 1997.
6. Seraphim, D., Lasky, R.C. and Che-Yu Li, "Principles of Electronic Packaging" Mcgraw Hill, 1989.
7. Strauss, R.," SMT Soldering Handbook", Newnes Elsevier , 1998
8. Zant, P.V., " Microchip Fabrication – a practical guide to semiconductor processing "McGraw Hill, 2000

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3					
CO2	3					
CO3	3		2			
CO4	3		2			
CO5	3		2			
Avg	(15/5)=3		(6/3)=2			

CM4011 ENVIRONMENT CONSCIOUS MANUFACTURING L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on sustainable manufacturing concepts and standards
- To gain an insight on green manufacturing initiatives
- To get familiarized with environment conscious design
- To explore methods that support environmental friendly manufacturing
- To understand the Life Cycle Assessment process

UNIT I SUSTAINABLE MANUFACTURING AND EMS: 9

Sustainable Manufacturing - Concepts and Methodologies to Help Promote Industrial Ecology - ISO 14000 series standards - Concepts of ISO 14001 - requirements of ISO 14001 – Environmental Management System benefits - Environmentally Conscious Manufacturing.

UNIT II GREEN MANUFACTURING: 9

Green Design and Quality Initiatives - Environmental Cost Accounting and Business Strategy - Accounting for an Environmentally Conscious Setting - The Development of Eco labelling Schemes

UNIT III RECYCLING: 9

Recycling as Universal Resource Policy - Innovation Towards Environmental Sustainability In Industry - A Systematic Framework for Environmentally Conscious Design

UNIT IV ENVIRONMENTAL ATTRIBUTES OF MANUFACTURING: 10

Environmental Attributes of Manufacturing Processes - Environmental Decision Support Systems - Decision Models for Reverse Production System Design - Environmentally Sound Supply Chain Management

UNIT V LIFE CYCLE ASSESSMENT 8

Life Cycle Assessment - Multipath way and Cumulative Risk Assessment - Reclamation And Recycling of Waste

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students shall be able to
CO1: Take advantage of sustainable manufacturing concepts and standards
CO2: Deploy green manufacturing initiatives
CO3: Apply the environment conscious design
CO4: Take advantage of environmental friendly manufacturing methods
CO5: Apply the Life Cycle Assessment process

REFERENCES

1. Besterfield, D.H., Besterfield, C.M., Besterfield, G.H. and Besterfield, M.S.,"Total Quality Management ", Pearson Education, 2002.
2. Gupta, S.M. and Lambert, A.J.D., "Environment Conscious Manufacturing", CRC Press, 2008.
3. Madu, C.N., "Handbook of Environmentally Conscious Manufacturing", Kluwer Academic Publisher, 2001.
4. Swamidass, P.M., "Encyclopedia of Production and Manufacturing Management", Kluwer Academic Publisher, 2000.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		2	2	3	3
CO2			2		3	3
CO3			2		3	3
CO4			2		3	3
CO5	1		2		3	3
Avg	(2/2)=1		(10/5)=2	(2/1)=2	(15/5)=3	(15/5)=3

CM4012 **EVOLUTIONARY COMPUTATION** **L T P C**
3 0 0 3

OBJECTIVES:

- To impart the knowledge in optimization,
- To explore multi objective optimization,
- To learn evolutionary algorithms,
- To understand Evolutionary strategies and programming.
- To get familiarized in Multi-Objective Evolutionary algorithm

UNIT I INTRODUCTION TO OPTIMIZATION: 9

Introduction to optimization - single and multi objective optimization - Evolutionary algorithms - principles of multi objective optimization.

UNIT II MULTI OBJECTIVE OPTIMIZATION: 9

Convex programming, Karush-Kuhn-Tucker conditions, Direct functional evaluation and derivative based optimization techniques;

UNIT III EVOLUTIONARY ALGORITHMS: 9

Simulated annealing, Tabu search; NFL theorem; Biological principles of evolution, General scheme of EAs, Representation, Selection schemes, Population evaluation, Variation operators; Constraint handling; Schema theorem; Binary coded genetic algorithm, Real coded genetic algorithm.

UNIT IV EVOLUTIONARY STRATEGIES AND EVOLUTIONARY PROGRAMMING 9

Evolutionary strategies, Evolutionary programming, genetic programming, Differential evolution, Particle swarm optimization;

UNIT V APPLICATIONS OF MULTI-OBJECTIVE EVOLUTIONARY ALGORITHMS: 9

Pareto-optimality, Multi-objective evolutionary algorithms; Statistical analysis of EC techniques; Customization in EAs; Applications of multi-objective evolutionary algorithms - Mechanical component design - Truss-structure design - Other applications.

TOTAL: 45 PERIODS

OUTCOME:

CO1: Demonstrate principles of optimization process
CO2: Make use of multi response optimization
CO3: Inference to the evolutionary programming
CO4: Evaluate the process parameters for optimization
CO5: Apply optimization techniques in mechanical component design

REFERENCES

1. Back, T., Fogal, D. B. and Michalewicz, Z., "Handbook of Evolutionary Computation", Oxford University Press, 1997.
2. Clerc, M.,"Particle Swarm Optimization", ISTE, 2006.
3. Deb, K., "Multi-objective Optimization using Evolutionary Algorithms", Wiley, 2001.
4. Fogel, D. B., "Evolutionary Computation, The Fossil Record", IEEE Press, 2003.
5. Goldberg, D., "Genetic Algorithms in Search, Optimization, and Machine Learning", Addison Wesley, 1989.
6. Price, K. , Storn, R. M. , and Lampinen, J. A. ,"Differential Evolution: A Practical Approach to Global Optimization", Springer, 2005.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1			1	3		
CO2			1	3		
CO3			1	3		
CO4			1	3		
CO5			1	3		2
Avg			(5/5)=1	(15/5)=3		(2/1)=2

CM4013 INTELLIGENT PRODUCT DESIGN AND MANUFACTURING L T P C
3 0 0 3

OBJECTIVES:

- To understand the basic principles of intelligent product design and manufacturing.
- To study the various techniques of knowledge representation.
- To study the different the modelling techniques in intelligent product design and manufacturing.
- To apply the neural networks in manufacturing systems.
- To understand and develop the web based CAD/CAM internet model.

UNIT I INTRODUCTION TO INTELLIGENT DESIGN AND MANUFACTURING: 9

Need - Internet technology and Manufacturing Industry - Digital enterprises - Manufacturing portals – Benefits.

UNIT II TECHNIQUES OF KNOWLEDGE REPRESENTATION 9

Artificial Neural Networks, Fuzzy Logic, Genetic Algorithms, Expert Systems with case studies.

UNIT III INTELLIGENT PRODUCT MODELING TECHNIQUES: 9

Intelligent CAD systems, integrating product and process design, manufacturing analysis and CAD/CAM integration, design methodology for automated manufacture, the impacts of intelligent process control on product design, and fuzzy knowledge-based controller design.

UNIT IV APPLICATION OF NEURAL NETWORKS: 9

Neural Networks for Intelligent Process Monitoring and Control : Applications to CNC machining, Metal Forming - Intelligent Manufacturing Planning, Scheduling and Control - Intelligent Assembly and Layout Planning.

UNIT V INTERNET BASED COLLABORATIVE CAD/CAM : 9

Applications to web based CAD, CAPP, CNC, Assembly planning, and Rapid Prototyping - Challenging issues of Collaborative CAD/CAM.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Demonstrate Internet technology in manufacturing Industry
CO2: Make use of techniques of Knowledge Representation
CO3: Analysis of various CAD/CAM system
CO4: Apply neural networks for intelligent process monitoring and control
CO5: Develop web based CAD/CAM internet model

REFERENCES

1. Dagli, C.H., “Intelligent systems in design and manufacturing”, ASME, 1994.
2. Huang, G.Q. and Mak, K.L., “Internet Applications in Product design and Manufacturing” ,Springer, 2003.
3. Kusiak, A., “Intelligent Design and Manufacturing”, Wiley-Interscience, 1992.
4. Parsaei, H.R. and Jamshidi, M., “Design and implementation of intelligent manufacturing systems”, Prentics Hall, 1995.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1		1	3	2		
CO2		2	3		3	
CO3	2	2	3			
CO4	3			3	3	3
CO5	3			3	3	3
Avg	(8/3)=2.66	(5/3)=1.66	(9/3)=3	(8/3)=2.66	(9/3)=3	(6/2)=3

CM4014 INTELLIGENT MANUFACTURING SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

To know the concepts of Artificial Intelligence
To Practice the methods of solving problems using Artificial Intelligence
To build components of intelligent decision support system for Manufacturing
To understand intelligent systems and its troubleshooting methods
To investigate and deploy Artificial Intelligence for future smart manufacturing factories.

UNIT I INTRODUCTION 9

Components of manufacturing – Soft and Hard Automation – Flexible Manufacturing Cell – Flexible handling methods -Basic concepts of Artificial intelligence and expert systems – Intelligent System Components -System architecture and Data flow – System Operations.

UNIT II ARTIFICIAL INTELLIGENCE LANGUAGES 9

Heuristic search-logic programming and reasoning-automatic programming-scope of AI-in manufacturing components of intelligent manufacturing Aspects of intelligence and AI Requirements of AI languages, LISP & PROLOG – Simple programs

UNIT III BUILDING OF KNOWLEDGE BASED SYSTEMS 9

Knowledge engineering-protocol analysis -fuzzy logic -Semantic networks, Learning systems Knowledge Engineering Knowledge representation – Knowledge acquisition and optimization -Knowledge based approaches to design mechanical parts and mechanisms and design for automated assembly.

UNIT IV INTELLIGENT SYSTEMS 9

Knowledge based system for material selection – Intelligent process planning system. Intelligent system for equipment selection -Intelligent system for project management & factory monitoring. Inference engine Vision programmes-factory vision systems -machine learning

UNIT V FACTORIES OF FUTURE 9

The role of Artificial Intelligence in the factory of the future Features of Experts systems -applications in manufacturing planning and control – Intelligent systems. Scheduling in manufacturing – scheduling the shop floor – Diagnosis & trouble shooting.

TOTAL 45 PERIODS

COURSE OUTCOMES:

CO1: Apply various knowledge based techniques
CO2: Build components of intelligent decision support system
CO3: Adopt intelligent system for Manufacturing
CO4: Demonstrate the concepts of Artificial Intelligence
CO5: Solve problems using Artificial Intelligence

REFERENCES

1. Andrew Kussiak, “Intelligent Manufacturing Systems”, Prentice Hall, 1990.
2. Kenneth R.Baker, “Introduction to sequencing and scheduling”, John Wiley & Sons, New York, 2009.
3. Richard W. Conway, William Maxwell and Louis W. Miller, “Theory of Scheduling”, Dover Publications, 2003.
4. Rich,E., “Artificial Intelligence”, McGraw Hill, 1986.
5. Simons, G.L, “Introducing Artificial Intelligence”, NCC Pub, 1990.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	3	3	2	2	1
CO2	2	3	3	2	3	2
CO3	3	3	1	2		2
CO4	3	3	2	3	2	3
CO5	3	3	3	2	2	1
Avg	(14/5)=2.8	(15/5)=3	(12/5)=2.4	(11/5)=2.2	(9/4)=2.25	(9/5)=1.8

CM4015 MICRO ELECTRO MECHANICAL SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To introduce MEMS, Microsystems, materials and working of MEMS and Microsystems
- To explain the scaling laws in miniaturization and design for microsysytems
- To familiarize with different microsystem fabrication processes.
- To learn packaging, interfaces and assembly of microsystems
- To gain knowledge in different measurement and characterization methods for MEMS

UNIT I INTRODUCTION 9

Overview of MEMS and Microsystems: MEMS and Microsystems, Evolution of Micro fabrication, Microsystems and Microelectronics, Microsystems and miniaturization-Materials for MEMS and Microsystems: substrates and wafers, active substrate materials, Silicon, Gallium Arsenide, Piezoelectric Crystals, Polymers, Packaging materials-Working principles of Microsystems: micro sensors, micro actuation, MEMS with micro actuators, Micro accelerometers, micro fluidics-Applications of Microsystems in various industries.

UNIT II MECHANICS, SCALING AND DESIGN 9

Engineering Mechanics for Microsystems design: Introduction, Static bending of Thin Plates, Mechanical Vibration, Thermomechanics, Thermofluid, Engineering and micro system design, Laminar fluid flow, Incompressible fluid Flow, Heat conduction in solids-Scaling Laws in Miniaturization, Introduction to scaling, Scaling in (Electrostatic forces electromagnetic forces, Electricity, fluid mechanics, heat transfer)-Microsystems Design: Design Consideration, Process design, Mechanical Design, Design of Micro fluidic Network systems

UNIT III MICRO SYSTEM FABRICATION PROCESSES 11

Introduction- Photolithography- Ion implantation- Chemical Vapor Deposition-Physical Vapor Deposition - clean room- Bulk micromachining :etching, isotropic and anisotropic etching, wet and dry etching-Surface micro machining :process, mechanical problems associated with surface micro machining- LIGA process :general description, materials for substrates and photo resists-SLIGA process-Abrasive jet micro machining-Laser beam micro machining- Micro Electrical Discharge Micro Machining –Ultrasonic Micro Machining- Electro chemical spark micro machining- Electron beam micro machining-Focused Ion Beam machining

UNIT IV MICROSYSTEMS PACKAGING 8

Introduction - Microsystems Packaging-Interfaces in Microsystems Packaging-Essential Packaging Technologies- Die preparation, surface bonding, wire bonding, sealing- Three dimensional Packaging-Assembly of Microsystems, Signal Mapping and Transduction

UNIT V MICROMETROLOGY AND CHARACTERIZATION 8

Microscopy and visualization- Lateral and vertical dimension- optical microscopy, Scanning white light interferometry, Confocal Laser scanning microscopy, Molecular measuring machine, Micro coordinate measuring machine- Electrical measurements – Physical and chemical analysis – XRD- SEM - Secondary Ion mass spectrometry- Auger Electron Spectroscopy, SPM

TOTAL: 45 PERIODS

OUTCOME:

CO1: Explain the concept of Micro Electro Mechanical systems
CO2: Develop micro system design
CO3: Identify the elements of MEMS system
CO4: Determine the scaling and design methods
CO5: Examine the micro metrology and characterization

REFERENCES

1. Franssila, S., “Introduction to Micro Fabrication” John Wiley & sons Ltd, 2004.ISBN:470-85106-6
2. Hak M.G., “MEMS Handbook”, CRC Press, ISBN: 8493-9138-5, 2006.
3. Hsu, T.R., “MEMS & Microsystems Design and Manufacture”, Tata McGraw Hill, 2002,ISBN: 9780070487093.
4. Jackson, M.J., “Microfabrication and Nanomanufacturing” Second edition,Taylor and Francis 2008.

5. Jain, V.K., “Introduction to Micromachining”Second edition, Narosa Publishing House, 2018.
6. McGeough, J.A., “Micromachining of Engineering Materials”, CRC Press, ISBN: 0824706447, 2001.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3		2	3		
CO2	2		3			
CO3	2		1			
CO4	3		2			
CO5	3		2			
Avg	(13/5)=2.6		(10/5)=2	(3/1)=3		

PD4391 PRODUCT LIFECYCLE MANAGEMENT L T P C

3 0 0 3

OBJECTIVES:

1. To understand history, concepts and terminology of PLM
2. To understand functions and features of PLM/PDM
3. To understand different modules offered in commercial PLM/PDM tools
4. To demonstrate PLM/PDM approaches for industrial applications
5. To Use PLM/PDM with legacy data bases, CAx & ERP systems

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III DETAILS OF MODULES IN APDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools

UNIT IV ROLE OF PLM ININDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance.

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

TOTAL:45PERIODS

OUTCOMES:

The students will be able to

1. Summarize the history, concepts and terminology of PLM
2. Use the functions and features of PLM/PDM
3. Use different modules offered in commercial PLM/PDM tools.
4. Implement PLM/PDM approaches for industrial applications.
5. Integrate PLM/PDM with legacy data bases, CAx& ERP systems.

CO	PO					
	1	2	3	4	5	6
1	1	2	2	1	-	-
2	2	2	2	1	-	-
3	2	1	2	1	-	-
4	1	1	3	1	-	-
5	1	1	1	1	-	-
Avg	1.4	1.4	2	1	-	-

01- Low 02- Medium 03 High

REFERENCES

1. Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management", Springer Publisher, 2008 (3rd Edition).
2. International Journal of Product Lifecycle Management, Inderscience Publishers
3. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.
4. John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007.
5. John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition).
6. Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2006.

CM4071 MANUFACTURING SYSTEM SIMULATION L T P C
3 0 0 3

OBJECTIVES:

- To discuss the importance and advantages of applying simulation and modelling techniques
- To teach various random number generation techniques, its use in simulation
- To explain the applications of random probability distributions in real time environments.
- To train students to solve discrete event problems using software.
- To train students on Simulation models using a simulation software.

UNIT I INTRODUCTION 9

Systems and its types, Types of Modelling, Principles used in Modeling, simulation as a decision making tool, types of simulation, Advantages and disadvantages of simulation, Steps in simulation model building - statistical models in simulation -discrete and continuous system

UNIT II RANDOM NUMBERS 9

Random number generation -Properties of Random Numbers –Generation of Pseudo Random Numbers – Techniques –Tests for Random Numbers

UNIT III RANDOM VARIATES 9

Random variate generation-Inverse Transform Technique –Direct Transform Techniques Convolution Method Acceptance Rejection Technique– Routines for Random Variate Generation, Testing -Analysis of simulation data.

UNIT IV ANALYSIS OF SIMULATION DATA 9

Input modelling-Fitness tests – verification and validation of simulation models – output analysis for a single model, Comparison and evaluation of alternate system design, Optimization using simulation.

UNIT V SIMULATION LANGUAGES AND CASE STUDIES 9

Simulation languages and packages-Case studies in WITNESS; FLEXSIM, ARENA, SIMQUICK-Simulation based optimization-Modelling and Simulation with Petrinets -Case studies in manufacturing and material handling system- Monte Carlo Simulation. Simulation of Single Server Queuing System. Simulation of manufacturing shop Simulation of Inventory System

TOTAL: 45 PERIODS

OUTCOMES

CO1: Explain the Manufacturing Models of Discrete event systems
CO2: Develop the Uncertainty using Random numbers and Random Variates
CO3: Analyze the verification & valediction of Models and Optimization
CO4: Demonstrate the concepts of modeling layers of society's critical infrastructure networks
CO5: Make use of tools to view and control simulations

REFERENCES

1. Geoffrey Gordon, "System Simulation", 2nd Edition, Prentice Hall, India, 2020.
2. Jerry Banks & John S.Carson, Barry L Nelson, “Discrete event system simulation”, Prentice Hall,2000.
3. Law A.M, “Simulation Modelling and Analysis”,Fifth edition, Tata Mc Graw Hill,2014.
4. NarsinghDeo, “System Simulation with Digital Computer”,Fith edition, Prentice Hall,2014.
5. Pidd, M, “Computer Simulation in Management Science”, Fifth edition,John Wiley & Sons, Inc,2016.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		3	1		
CO2	1		3	1		
CO3	1		3	1		
CO4	1		3	1		
CO5	1		3	1		
Avg	(5/5)=1		(15/5)=3	(5/5)=1		

CM4016 MANUFACTURING INFORMATION SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the evolution of order policies and agile manufacturing information systems
- To elaborate database terminologies, data models, data independence and trends in database
- To impart knowledge on database designing, normalization types and query languages
- To give an overview of modules involved in inventory, process flow and shop floor control
- To be acquainted with integration of the modules to function as a single application that aids different departments of factory

UNIT I INTRODUCTION: 7

The Evolution of order policies, from MRP to MRP II to ERP – Agile Manufacturing Information Systems, Manufacturing Database Integration.

UNIT II DATABASE: 9

Terminologies – Entities and attributes – Data models, schema and subschema - Data Independence – ER Diagram – UML notation for describing the enterprise–wide data objects- Trends in database.

UNIT III DESIGNING DATABASE: 9

Hierarchical model – Network approach- Relational Database concepts, principles, keys,– functional dependency – Normalization types – relational operations- Query Languages-Case studies.

UNIT IV MANUFACTURING CONSIDERATION: 10

The product and its structure, inventory and process flow – Shop floor control Data structure and procedure – various models – the order scheduling module, Input/output analysis module, and stock status database – the complete IOM database.

UNIT V INFORMATION SYSTEM FOR MANUFACTURING: 10

Parts oriented production information system – concepts and structure – Computerized production scheduling, online production control systems, Computer based production management system, computerized manufacturing information system -RFID-Telecommunication– case study.

TOTAL: 45 PERIODS

OUTCOMES

At the end of this course, the students shall be able to

CO1: Perceive the evolution of order policies, agile manufacturing information systems and manufacturing database integration

CO2: Explain the database terminologies, data models, data independence and trends in database

CO3: Acquire knowledge on database designing, normalization types and query languages

CO4: Elaborate modules involved in inventory, process flow and shop floor control

CO5: Understand the integration of the modules to function as a single application that aids different departments of factory

REFERENCES

1. Date, C.J., "An Introduction to Database Systems" Addison Wesley", 8th Edn,. 2004.
2. Franjo, C., "Manufacturing Information & Data Systems Analysis, Design & Practice", Butterworth-Heinemann, 2002.
3. Kerr, R., "Knowledge based Manufacturing Management", Addison-Wesley, 1991.
4. Oliver, G. and Wolfhard, K., "RFID in Manufacturing", Kubach.vwe.,2008
5. Orlicky, G., "Material Requirements Planning",Third edition McGraw-Hill, 2011.
6. Sartori, L.G., "Manufacturing Information Systems", Addison-Wesley Publishing Company, 1988.
7. Weiming S, "Information Technology for Balanced Manufacturing Systems", Springer, 2006.
8. www.ist.psu.edu
9. www.cse.wustl.edu (UML Notation Guide)

CO	PO					
	1	2	3	4	5	6
1	1		3	2		
2	1		3	3		
3	2		3	2		
4	2		3	2		
5	1		3	3		
Avg	(7/5)=1.4		(15/5)=3	(12/5)=2.4		

CM4017 SUSTAINABLE MANUFACTURING L T P C

3 0 0 3

COURSE OBJECTIVES

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT I ECONOMIC SUSTAINABILITY 9

Industrial Revolution-Economic sustainability: globalization and international issues- Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

UNIT II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations - Modelling and assessing environmental sustainability

UNIT III SUSTAINABILITY PRACTICES 9

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers -Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model

UNIT IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs

UNIT V TRENDS IN SUSTAINABLE OPERATIONS 9

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - Influence of product design on operations - Process analysis - Capacity management – Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Discuss the importance of economic sustainability.
CO2: Describe the importance of sustainable practices.
CO3: Identify drivers and barriers for the given conditions.
CO4: Formulate strategy in sustainable manufacturing.
CO5: Plan for sustainable operation of industry with environmental, cost consciousness

REFERENCES:

1. Davim J.P., “Sustainable Manufacturing”, John Wiley & Sons., United States, 2010, ISBN: 978-1-848-21212-1.
2. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
3. Jovane F., Ęmper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United States, ISBN 978-3-540-77011-4.
4. Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
5. Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United states, 2012, ISBN 978-3-642-27289-9.

IL4072 **ENTERPRISE RESOURCE PLANNING** **L T P C**

3 0 0 3

OBJECTIVES:

- Describe an idea about ERP
- Creating awareness of core and extended modules of ERP
- Extract knowledge of ERP implementation cycle
- Gaining knowledge about effects of ERP after its implementation.
- Understanding the emerging trends on ERP

UNIT I INTRODUCTION **9**

Overview of enterprise systems – Evolution - Risks and benefits - Fundamental technology - Issues to be consider in planning design and implementation of cross functional integrated ERP systems.

UNIT II ERP SOLUTIONS AND FUNCTIONAL MODULES **9**

Overview of ERP software solutions- Small, medium and large enterprise vendor solutions, BPR, and best business practices - Business process Management, Functional modules.

UNIT III ERP IMPLEMENTATION **9**

Planning Evaluation and selection of ERP systems - Implementation life cycle - ERP implementation, Methodology and Frame work- Training – Data Migration. People Organization in implementation- Consultants, Vendors and Employees.

UNIT IV POST IMPLEMENTATION **9**

Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of ERP Implementation.

UNIT V EMERGING TRENDS ON ERP **9**

Extended ERP systems and ERP add-ons -CRM, SCM, Business analytics - Future trends in ERP systems-web enabled, Wireless technologies, cloud computing

TOTAL: 45 PERIODS

OUTCOMES

CO1: Get an idea about ERP
CO2: Awareness of core and extended modules of ERP
CO3: Knowledge of ERP implementation cycle
CO4: Gain knowledge about effects of ERP after its implementation.
CO5: Understand the emerging trends on ERP

REFERENCES

1. Alexis Leon, Enterprise Resource Planning, second edition, Tata McGraw-Hill, 2008.
2. Jagan Nathan Vaman, ERP in Practice, Tata McGraw-Hill, 2008
3. MahadeoJaiswal and Ganesh Vanapalli, ERP Macmillan India, 2009
4. Sinha P. Magal and Jeffery Word, Essentials of Business Process and Information System, Wiley India, 2012
5. Vinod Kumar Grag and N.K. Venkitakrishnan, ERP- Concepts and Practice, Prentice Hall of India, 2006.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	-	-	-
CO2	-	2	1	-	-	-
CO3	-	-	1	-	-	-

CO4	-	-	1	1	-	-
CO5	-	-	-	1	1	-
Avg.	**1/1=1**	**(1+2)/2=1.5**	**(1+1+1)/3=1**	**(1+1)/2=1**	**1/1=1**	-

1-low, 2-medium, 3-high, '-"- no correlation

CC4071 ADVANCED MACHINE TOOL DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Selecting the different machine tool mechanisms.
2. Designing the Multi speed Gear Box and feed drives.
3. Designing the machine tool structures.
4. Designing the guideways and power screws.
5. Designing the spindles and bearings.

UNIT I INTRODUCTION TO MACHINE TOOL DESIGN 9

Introduction to Machine Tool Drives and Mechanisms, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission

UNIT II REGULATION OF SPEEDS AND FEEDS 9

Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design

UNIT III DESIGN OF MACHINE TOOL STRUCTURES 9

Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage.

UNIT IV DESIGN OF GUIDEWAYS AND POWER SCREWS 9

Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws.

UNIT V DESIGN OF SPINDLES AND SPINDLE SUPPORT 9

Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness

TOTAL = 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. Select the different machine tool mechanisms.
2. Design the Multi speed Gear Box and feed drives.
3. Design the machine tool structures.
4. Design the guideways and power screws.
5. Design the spindles and bearings.

REFERENCES:

1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 3rd edition 2012
2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2015
3. K Pal, S. K. Basu, "Design of Machine Tools", 6th Edition. Oxford IBH, 2014
4. N. S. Acherkhan, "Machine Tool Design", Volume 2 University Press of the Pacific, 2000
5. F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1964

6. F. Koenigsberger, Machine Tool Structures, Pergamon Press,1970.

CO	PO					
	1	2	3	4	5	6
1	3	3	3	2	3	3
2	3	3	3	2	3	3
3	3	3	3	2	3	3
4	3	3	3	2	3	3
5	3	3	3	2	3	3
AVg.	3	3	3	2	3	3

CM4018 MANAGEMENT OF MANUFACTURING SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To teach the different aspects of manufacturing and competitiveness
- To Identify the flow design for products
- To make the students Select job design and work measurement
- Train the students to evaluate MRP systems and inventory model
- To create ability to apply reengineering concepts in manufacturing

UNIT I INTRODUCTION: 6

Elements – Manufacturing Strategies and competitiveness-Meeting the competitive Project management.

UNIT II DESIGNING OF PRODUCTS: 9

Process selection-Process flow Design – Operations Technology -Waiting line management-Computer simulation of waiting lines – Quality management.

UNIT III DESIGN OF FACILITIES AND JOBS: 10

Capacity planning – Strategies – Planning service capacity - JIT – Facility location and layout - Job Design and Work measurement.

UNIT IV INVENTORY SYSTEMS AND MRP: 10

Definition-Purposes of Inventory-Inventory models-Fixed order Quantity models and Fixed-time period models. MRP Systems-MRP system structures- Improvements for MRP system-Advanced MRP-type systems.

UNIT V REVISING THE SYSTEM: 10

Operations consulting – BPR - Synchronous Manufacturing and theory of Constraints.

TOTAL: 45 PERIODS

OUTCOME:

CO1: Able to Classify the different aspects of manufacturing
CO2: Able to Identify the flow design for products
CO3: Ability to Evaluate MRP systems and inventory model
CO4: Capacity to Select job design and work measurement
CO5: Know the procedure to apply reengineering concepts in manufacturing

	PO					
	1	2	3	4	5	6
CO1	3	2	1	2	3	3
CO2	3	2	1	2	3	3
CO3	3	2	1	2	3	3

CO4	3	2	1	2	3	3
CO5	3	2	1	2	3	3
Avg	(15/5)=3	(10/5)=2	(5/5)=1	(10/5)=2	(15/5)=3	(15/5)=3

REFERENCES:

1. Chary, S.N., "Production and Operations Management", Tata McGraw-Hill, 5th Edition 2017.
2. Chase, Aquilano and Jacobs, "Production and Operations Management", 4th Edition, Tata McGraw Hill, 2010.
3. Jay, H. and Render, B.,"Production and Operations Management: Strategic and Tactical Decisions", Business & Economics – 1996.
4. Operations Management, Jae K. Shim, Joel G. Siegel - Business & Economics, 1999.
5. Robert, A.O., "Manufacturing management: a quantitative approach", International Textbook Co, 1968.

CM4019 DESIGN OF FLUID POWER SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- To explain the principles of Hydraulic actuation systems and valves
- To learn hydraulic circuits suitable for different applications
- To get exposure on principles of Pneumatic systems and Pneumatic circuits
- To learn various designing methods of Pneumatic circuits
- To understand the applications of computer control in fluid power

UNIT I OIL HYDRAULIC SYSTEMS: 9

Hydraulic Power Generators - Selection and specification of pumps, pump characteristics - Linear and Rotary Actuators - selection, specification and characteristics - Pressure - direction and flow control valves - relief valves, non-return and safety valves - Hydraulic actuation systems.

UNIT II HYDRAULIC CIRCUIT DESIGN: 9

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits – press circuits - hydraulic milling machine - grinding, planning, copying, forklift, earth mover circuits – Design and methodology-Sequential circuits, cascade, circuits - Compound and combination circuit design - selection of components - safety and emergency mandrels.

UNIT III PNEUMATIC SYSTEMS AND CIRCUITS: 9

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions - modules and their integration.

UNIT IV PNEUMATIC CIRCUIT DESIGN: 9

Sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design - combination circuit design - hydro pneumatic circuits - Pneumatic equipments - selection of components - design calculations –application.

UNIT V COMPUTER CONTROL AND MAINTENANCE OF FLUID POWER CIRCUITS: 9

Fuzzy logic in fluid power circuits- PLC in fluid powers- PLC ladder diagram – Low cost automation - Robotic circuits - Installation -Fault finding in fluid power circuits.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to
CO1: Demonstrate various Hydraulic actuation systems and valves
CO2: Design and analyse hydraulic circuits
CO3: Design and analyse pneumatic circuits
CO4: Choose a suitable designing method for a pneumatic circuit
CO5: Apply fuzzy logic in fluid power and to identify suitable maintenance methods

REFERENCES

1. Bolton W., “Pneumatic and Hydraulic Systems ", Butterworth - Heineman, 1997.
2. Esposito. A., “Fluid power with Applications ",7th Prentice Hall, 2013.
3. Majumdar, S., “Oil Hydraulic Systems: Principles And Maintenance”, Tata McGraw-Hill Education, 2001.
4. Majumdar, S.R., “Pnuematic Systems: Principles And Maintenance”, Tata McGraw-Hill Education, 2001.
5. Parr, A., “Hydraulics and Pneumatics ", (HB), Jaico Publishing House, 1999.
6. Pease D.A. and Pippenger J.J., “Basic Fluid Power ", Prentice Hall, 1987.
7. Pessen, D.W., “Industrial Automation Circuit Design and Components”, Wiley India Pvt. Ltd., Reprint 2011.

CO	PO					
	1	2	3	4	5	6
1	2		2			
2	2		2			
3	2		2			
4	2		2			2
5	2		3			3
Avg	**(10/5)=2**		**(11/5)=2.2**			**(5/2)=2.5**

IL4092 PROJECT MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

Compare various models used in project selection.
Define project planning, and estimate the cost involved.
Apply network techniques for project scheduling and resource allocation.
Summarize the information needed planning, monitoring and controlling cycle of a project.
Recognize the values of project audit.

UNIT I STRATEGIC MANAGEMENT AND PROJECT SELECTION 9

Project selection models, Project portfolio process, Analysis under uncertainty, Project organization, Matrix organization

UNIT II PROJECT PLANNING AND COST ESTIMATION 9

Work breakdown structure, Systems integration, Interface coordination, Project life cycle, Conflict and negotiation, Estimating Project Budgets, Process of cost estimation.

UNIT III PROJECT IMPLEMENTATION 9

Scheduling: Network Techniques PERT and CPM, Risk analysis using simulation, CPM- crashing a project, Resource loading, leveling, and allocation.

UNIT IV MONITORING AND INFORMATION SYSTEMS 9

Information needs and the reporting process, computerized PMIS, Earned value analysis, Planning-Monitoring-Controlling cycle, Project control: types of control processes, design of control systems, control of change and scope

UNIT V PROJECT AUDITING 9

Construction and use of audit report, Project audit life cycle, Essentials of audit and evaluation, Varieties of project termination, the termination process, The Final Report – A project history

TOTAL: 45 PERIODS

OUTCOMES:

CO1 - Understand various models used in project selection.

CO2 - Acquire knowledge in project planning, and estimate the cost involved.
CO3 - Prepare Project Scheduling and resource allocation.
CO4 - Understand about planning, monitoring and controlling cycle of a project.
CO5 - Understand the values of project audit.

REFERENCES:

1. Harold Kerzner, Project Management – A Systems Approach to Planning, Scheduling and Controlling, John Wiley and Sons, 12th edition, 2017.
2. Jack R. Meredith, and Samuel J. Mantel Jr, Project Management – A Managerial Approach, John Wiley and Sons, 10th edition, 2017.
3. Panneerselvam .R, Senthil Kumar .P, Project Management, PHI, 2009.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	-	-	-
CO2	-	1	1	-	1	-
CO3	-	1	-	-	1	-
CO4	-	-	1	-	1	-
CO5	-	-	1	1	-	-
Avg.	**1/1=1**	**(1+1+1)/3=1**	**(1+1+1)/3=1**	**1/1=1**	**(1+1+1)/3=1**	**-**

1 - low, 2-medium, 3-high, '-"- no correlation

CM4020 RELIABILITY AND TOTAL PRODUCTIVE MAINTENANCE L T P C
3 0 0 3

OBJECTIVE:

- To gain an insight on Reliability function and life time calculations relevant to maintenance
- To get familiarized with various failure data analysis methods
- To be acquainted with various reliability prediction methods
- To get accustomed with reliability estimation techniques
- To understand the concepts of Total **P**roductive Maintenance

UNIT I INTRODUCTION 9

Reliability function - MTBF - MTTF - mortality curve - availability -Maintainability.

UNIT II FAILURE DATA ANALYSIS: 9

Repair time distributions - exponential, normal, log normal, gamma, and Weibull - reliability data requirements - Graphical evaluation.

UNIT III RELIABILITY PREDICTION: 9

Failure rate estimates - Effect of environment and stress - Series and Parallel systems - RDB analysis – Standby Systems - Complex Systems.

UNIT IV RELIABILITY MANAGEMENT: 9

Reliability demonstration testing - Reliability growth testing - Duane curve -Risk assessment - FMEA, Fault tree.

UNIT V TOTAL PRODUCTIVE MAINTENANCE: 9

Causes of Machine Failures - Downtime - Maintenance policies - Restorability predictions - Replacement models - Spares provisioning -Maintenance management – Total Productive Maintenance – Maximizing equipment effectiveness – Organizing for TPM implementation – Implementation – TPM small group activities.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students shall be able to

CO1: Use the Reliability function and life time calculations relevant to maintenance

CO2: Apply the failure data analysis methods

CO3: Deploy various reliability prediction methods

CO4: Apply the reliability estimation techniques

CO5: Take advantage of Total Productive Maintenance concepts

REFERENCES

1. Birolini, A., “Reliability Engineering: Theory and Practice”,2nd edition, Springer, 2013.
2. Gopalakrishnan. P., and Banerji, A.K., “Maintenance and Spare Parts Management ", Prentice Hall of India, New Delhi, 1996.
3. Kales, P., “Reliability for technology Engineering and Management ", Prentice Hall, New Jersey, 1998.
4. Modarres,M., "Reliability and Risk Analysis ", Meral Dekker Inc., 1993.
5. Nakajima, S., “Introduction to TPM”, Productivity Press, 1988.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		3			
CO2	1		3			
CO3	1		3			
CO4	1		3			
CO5	1		3	3		
Avg	(5/5)=1		(15/5)=3	(3/1)=3		

CM4021 SENSORS FOR MANUFACTURING AND CONDITION MONITORING L T P C

3 0 0 3

OBJECTIVES:

- To make students familiar with various sensors in manufacturing and signal processing.
- To impart knowledge on sensors used in workpiece monitoring.
- To explain various sensors used in machine tool monitoring.
- To learn various sensors used in machining process monitoring.
- To brief the advanced and smart sensor technologies.

UNIT I INTRODUCTION TO SENSORS 9

Role of sensors in manufacturing and condition monitoring – Principles – Classification Applications – Basic requirements of sensor – Signal processing and decision making.

UNIT II SENSORS FOR WORKPIECE MONITORING 9

Mechanical, Electrical, Electro-mechanical, Opto-electrical, Optical, Pneumatic, Capacitance, Eddy-current and Magnetic sensors.

UNIT III SENSORS FOR MACHINE TOOL MONITORING 9

Position measurements: Linear, angular and velocity sensors – Calibration of machine tools – Collision detection measurements.

UNIT IV SENSORS FOR MACHINING PROCESSES 9

Sensors for condition monitoring: Force, torque, power, temperature, vibration, acoustic emission, tool sensors, chip control sensors – Adaptive control system – Intelligent systems for machining processes.

UNIT V ADVANCED SENSORS 9

Optical and machine vision sensors – Smart/Intelligent sensors – Integrated sensors – Robot sensors – Micro-sensors – Nano-sensors.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course, the students shall be able to:

CO1: Recognize the importance of sensors and condition monitoring in manufacturing.

CO2: Identify suitable sensors for monitoring workpiece during machining operation.

CO3: Identify suitable sensors for monitoring machine tool during machining operation.

CO4: Identify suitable sensors in monitoring the machining process.

CO5: Perceive the usage and importance of advanced sensors in manufacturing industries.

REFERENCES

1. Considine, D.M. and Glenn, D., "Standard Handbook of Industrial Automation: Advanced Industrial Technology 01", Chapman and Hall, New York, DOI: 10.1017/S0263574700004392, 1987.
2. Sinclair, I.R., "Sensors and Transducers" Elsevier India Private Limited, New Delhi, India, ISBN: 978-0-7506-4932-1, 2001.
3. Tönshoff, H.K. and Inasaki, I., "Sensors in Manufacturing: Sensors Applications- Volume1", Wiley-VCH Verlag GmbH, Weinheim, ISBNs: 3-527-29558-5 (Hardcover); 3-527-60002-7 (Electronic), 2001.
4. Venkatesh, V.C. and Chandrasekaran, H., "Experimental Techniques in Metal Cutting", Prentice-Hall of India Private Limited, New Delhi, India, ISBN: 0-87692-449-6, 1987.
5. Wang, L. and Gao, R.X., "Condition Monitoring and Control for Intelligent Manufacturing", Springer-Verlog London Limited, ISBN-13:978-1-84628-263-3, 2006.

CO	PO					
	1	2	3	4	5	6
1	1		3			
2	1		3			
3	1		3			
4	1		3			
5	1		3	1		
Avg	(5/5)=1		(15/5)=3	(1/1)=1		

CM4091	GREEN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To expose the students to the basics of environmental sustainability and impact assessment objectives.
2. To incorporate knowledge about the environmental based improvements towards lean manufacturing systems.
3. To analyze various machineries with intent to conserve energy
4. To analyze hazardous and solid wastes with intent to point out areas of adverse environmental impact and how this impact could be minimized or prevented.
5. To impart the knowledge about the need, procedure and benefits of Green-Co rating.

UNIT – I ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT 9

Environmental impact assessment objectives – Legislative development – European community directive – Hungarian directive. Strategic environmental assessment and sustainability appraisal. Regional spatial planning and environmental policy.

UNIT – II LEAN MANUFACTURING AND GREEN ENERGY SYSTEM 9

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing. World energy consumption – Greenhouse effect, Global warming. Energy conservation and measurement principles with their applicability in engineering and process industries.

UNIT – III ENERGY SAVING MACHINERY AND COMPONENTS 9

Electricity Billing: Components and Costs – kVA – Need and Control – Determination of kVA demand and Consumption. Selection of fans, pumps and Compressors – Performance Evaluation – Cause for inefficient operation – scope for energy conservation.

UNIT – IV HAZARDOUS AND SOLID WASTE MANAGEMENT 9

Hazardous waste: definition, terminology, classification and Sources – Need for hazardous waste management: Need, Handling, methods of collection, storage and transport with suitable examples. Solid waste management: Need, Waste prevention and Life cycle assessment. Collection, storage, reuse and recycling of solid waste with suitable examples.

UNIT – V GREEN CO-RATING 9

Ecological Footprint - Need for Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types of Rating – Green Co-Benefits – Case Studies of Green Co-Rating.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the Concepts of environmental sustainability and environmental impact assessment objectives

CO2: Apply suitable schemes towards design of green manufacturing requirements.

CO3: Analyze manufacturing processes towards conservation of energy.

CO4: Analyze manufacturing processes towards minimization or prevention of hazardous and solid wastes.

CO5: Acquire Knowledge of green co-rating and its benefits are well known to the students.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	1	1	1
CO2	1	-	-	1	1	1
CO3	1	-	-	1	1	1
CO4	1	-	-	1	1	1
CO5	1	-	-	1	1	1
AVG.	1	-	-	1	1	1

REFERENCES:

1. Dornfield David, Green Manufacturing, Springer, 2013
2. Davim J Paulo, Green Manufacturing Processes and Systems, Springer, 2013
3. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009
4. World Commission on Environment and Development (WCED), Our Common Future, Oxford
5. University Press 2005.
6. Green Co Case Study Booklet, CII – Sohrabji Godrej Green Business Centre, 2015

CM4022 MATERIAL CHARACTERIZATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge in specimen preparation techniques ,microstructure evaluation of materials.
- To elaborate X-ray diffraction techniques and crystal structure identification.
- To acquire knowledge in various microscopy techniques
- To get insights into different methods of chemical and thermal analysis
- To understand and practice various mechanical testing methods.

UNIT I MICRO STRUCTURAL EVALUATION: 9

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials.

UNIT II CRYSTAL STRUCTURE ANALYSIS: 9

Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT III ELECTRON MICROSCOPY: 9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM - Applications .

UNIT IV CHEMICAL AND THERMAL ANALYSIS: 9

Basic principles, practice and applications of X-ray spectrometry, Wave dispersive X- ray spectrometry, Auger spectroscopy, Secondary ion mass spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR) – proton induced X-ray Emission spectroscopy, Differential thermal analysis, Differential Scanning Calorimetry (DSC) and Thermo Gravimetric Analysis (TGA)

UNIT V MECHANICAL TESTING: 9

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Ductility Measurement – Impact Test – Charpy & Izod. Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – Applications of Dynamic Tests.

TOTAL: 45 PERIODS

OUTCOME:

CO1: Apply various material characterization techniques for research and analysis.
CO2: Evaluation of microstructure for materials
CO3: Explain the crystal structure analysis, electron microscopy
CO4: Analyze the Chemical, Thermal analysis
CO5: Make use of mechanical testing methods.

REFERENCES

1. Cherepin and Malik, “Experimental Techniques in Physical Metallurgy", Asia Publishing Co. Bombay, 1968.
2. Culity, B.D., Stock, S.R. and Stock, S., “Elements of X ray Diffraction”, (3rd Edition). Prentice Hall, 2001.
3. Davis, H.E., Hauck, G. and Troxell, G.E., “The Testing of engineering Materials”, (4th Edition), McGraw Hill, College Divn., 1982.
4. Goldsten, I.J., Dale, E., Echin, N.P. and Joy, D.C., “Scanning Electron Microscopy & X ray- Micro Analysis”, (2nd Edition), ISBN – 0306441756, Plenum Publishing Corp., 2000.
5. Grundy, P.J. and Jones, G.A.,”Electron Microscopy in the Study of Materials”, Edward Arnold Limited, 1976.
6. Morita, S., Wiesendanger, R. and Meyer, E., “Noncontact Atomic Force Microscopy” Springer, 2002
7. Newby, J., “Metals Hand Book- Metallography & Micro Structures”, (9th Edition), ASM International, 1989.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3		2			
CO2	3		1		2	
CO3	3		1			
CO4	3		1			
CO5	3		2			2
Avg	(15/5)=3		(7/5)=1.4		(2/1)=2	(2/1)=2

CM4023 TOOL ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

- To introduce the various materials and tools for production of components.
- To impart knowledge in design of various cutting tools and its nomenclature.
- To familiarize in designing dies for various processes.
- To understand the design of differenent jigs and fixtures
- To be acquainted with various gauges and tool design for CNC machines.

UNIT I INTRODUCTION: 9

Broad Classification of Tools-Cutting tools, Dies, Holding and Measuring tools, Tool materials and heat treatment- Ferrous, Non-ferrous and Non metallic materials, tool making practices.

UNIT II DESIGN OF CUTTING TOOLS: 9

Single Point Cutting Tools: Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, planers etc. Chip breakers and their design. Multipoint Cutting Tools: Classification and specification, nomenclature, Design of drills, milling cutters, broaches, taps etc. Design of Form Tools: Flat and circular form tools, their design and applications.

UNIT III DESIGN OF DIES: 9

Classification of dies, Design of Dies for Bulk metal Deformation-Wire Drawing, Extrusion, Forging and Rolling; Design of Dies for Sheet metal: Blanking and Piercing, Bending and Deep-drawing; Design of Dies used for Casting and Moulding, Powder Metallurgy die design.

UNIT IV DESIGN OF JIGS AND FIXTURES: 9

Classification of Jigs and Fixtures, Fundamental Principles of design of Jigs and Fixtures, Location and Clamping in Jigs and fixtures, Simple design for drilling Jigs, Milling fixtures etc. Indexing Jigs and fixtures.

UNIT V DESIGN OF LIMIT GAUGES AND TOOL DESIGN FOR CNC MACHINES: 9

Fixed gauges, gauge tolerances, indicating gauges, automatic gauges, selection of materials, tool design for CNC machines- fixture design, cutting tools, tool holding, tool pre-setter, automatic tool changers and positioners.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Apply domain knowledge will increase their employability skills
CO2: Make use of this knowledge to develop innovative ideas work holding methods
CO3: Explain the encourages to involve in research in the area of machining
CO4: Improve the design of jigs and fixtures
CO5: Identify the measuring gauges

REFERENCES

1. Donaldson, C., “Tool Design”, Tata Mc-Graw Hill, 2006
2. Grant, H,E., “Jigs and Fixtures, Tata Mc-Graw Hill, 2006
3. Joshi, P.H., “Jigs and Fixtures, Tata Mc-Graw Hill, 2003
4. Kempster, M.H.A., “Principles of Jig and Tool Design”, English University Press Ltd.,1968.
5. Pollack, H.W., “Tool Design” Reston Publishing Company, Inc. 1976.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	2	1	3	2	2
CO2			1	3	3	
CO3			1	2	2	
CO4			1	2	1	
CO5		2	1			
Avg	(1/1)=1	(4/2)=2	(5/5)=1	(10/4)=2.5	(8/4)=2	(2/1)=2

CM4024 TOTAL QUALITY SYSTEMS AND ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To gain an insight on Totally quality systems
- To get familiarized with various quality audit systems
- To get acquainted with elements of TQM
- To appreciate implementation of quality by design concepts
- To get acquainted with the laws that governs the product quality and safety

UNIT I INTRODUCTION: 9

Definition of Quality and TQM - Importance of quality - Principles of Quality Management - Pioneers of TQM - Quality costs - Customer Orientation - Benchmarking - Re-engineering - Concurrent Engineering.

UNIT II PRACTICES OF TQM: 9

Quality system - ISO 9001:2000 - QS 9000, ISO 14000 - Quality Auditing - Leadership - Organisational Structure - Team Building - Information Systems and Documentation.

UNIT III TECHNIQUES OF TQM: 9

Single Vendor Concept - JIT - Quality Function deployment - Quality Circles - KAIZEN - SGA - POKA YOKE - Taguchi Methods.

UNIT IV QUALITY BY DESIGN: 9

Introduction – Rationale for implementation – Benefits– Teams – Communication models – Implementation – Tools – Misconceptions and Pitfalls.

UNIT V PRODUCTS LIABILITY: 9

Introduction – Product safety law – products liability law – defenses – Proof and the expert witness – Financial Loss – The future of products liability – Prevention.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students shall be able to

CO1: Assess the Totally quality system concepts
CO2: Recognize various quality audit systems
CO3: Evaluate various elements of TQM
CO4: Implement the quality by design concepts
CO5: Recognize the laws that governs the product quality and safety

REFERENCES

1. Baird, C.W., “The Six Sigma Manual for Small and Medium Businesses”, Atlantic Publishing Company (FL), Reprint 2011.
2. Bank, J., " The Essence of Total Quality Management ", Prentice Hall of India Pvt.Ltd., 1995.
3. Besterfield, D.H., Besterfield, C.M, Besterfield, G.H. and Besterfield, M.S., “Total Quality Management ", Pearson Education, 2002.
4. Dalela, S. and Saurabh, “ISO 9000 A Manual for Total Quality Management ", S.Chand and Company Ltd., 1997.
5. Noori, H. and Radford,R., " Production and Operations management - Total Quality and Responsiveness ", McGraw-Hill Inc, 1995.
6. Zairi, M., “Total Quality Management for Engineers ", Woodhead Publishing Limited 1991.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		2	3		2
CO2	1		2	3		2
CO3	1		2	3		2
CO4	1		2	3		2
CO5	1		2	3		2
Avg	(5/5)=1		(10/5)=2	(15/5)=3		(10/5)=2

CM4025 WAREHOUSE LAYOUT PLANNING AND PART FEEDING METHODS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on various layout planning methods
- To get familiarized with various racking systems
- To gain an insight on material handling systems
- To learn various part feeding methods, optimum design of feeding routes and feeding methods
- To develop knowledge on warehouse management systems, safety requirements of ware house panning

UNIT I LAYOUT PLANNING: 8

Layout Planning - Importance of Layout Planning - General Steps in Layout and Space Requirements Planning - Warehouse Activities - Determining Space Requirements – Develop realistic and Ideal Layout for Storage and Retrieval – Material storage methods for each part

UNIT II RACKING SYSTEMS FOR WAREHOUSE: 9

Selection of Ware House Equipments and Material Handling Systems - Racking and Shelving Systems - Rack Planning Considerations - General Categories of Rack Systems - Large Products Storage System - Pallet Storage Systems Selection - Selection of Racking Systems - Technical Specification of the High Rack System - Design Standard for Racking Systems - Layout of High Rack Storage - Warehouse Floors - Industrial Floorings - Floor Loading and Preparation – Calculations.

UNIT III MATERIAL HANDLING SYSTEMS FOR WAREHOUSE: 9

Material Handling System - Material Flow Path - Selection Criteria to Determine Equipment - Material Handling Equipment Classification – MHE Manufacturer's Worldwide Ranking - Comparison of Fork Lift, Reach Truck and Narrow Aisle Truck - MHE Service and Battery Charging - Crane Design Requirements

UNIT IV PART FEEDING: 10

Part feeding - Number of Tow Truck Requirements - Calculations - Kitting Trolley Route Map - Kitting Time Estimation - Kitting Trolley Feeding Man Power Calculation - Kitting Trolley Design Methodology - Assumptions in Kitting Design - Kit Trolley Design - Key Ware House Planning- Issues to be Considered during Ware Housing Planning - Check List for Warehouse Layout Planning - Return on Assets

UNIT V WAREHOUSE MANAGEMENT SYSTEMS, SAFETY AND STAFFING 9

WMS Support in Ware House Management - Benefits of a WMS - Components of a WMS - WMS Data - WMS Functions - WMS Reports - Ware House Safety Requirements, Warehouse Staffing - Personnel Requirements for a Typical Warehouse.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Apply the Design and plan warehouse layouts
CO2: Explain the Plan racking systems
CO3: Make use of material handling systems for warehouse requirements.
CO4: To take advantage of various part feeding mechanisms
CO5: Develop knowledge on warehouse management systems and identify the safety requirements of warehouse panning

REFERENCES

1. Bartholdi, J.J. and Hackman, S.T., "Warehouse & Distribution science", Release 0.89, The Supply chain and logistics Institute, School of Industrial and systems Engineering, Georgia Institute of technology, Atlanta, GA 30332-0205 USA, Revised August 20, 2008.
2. Frazelle, E.H.,"World-Class warehousing and Material handling", TATA McGraw-Hill Edition 2004.
3. Hanson, R., "In-plant materials supply: Supporting the choice between kitting and continuous supply", Department of Technology Management and Economics, Chalmers University of Technology, Gothenburg, Sweden 2012. (http://publications.lib.chalmers.se/records/fulltext/155418.pdf)
4. IS 1893(Part 1): 2002, Indian Standard, Criteria For Earthquake Resistant Design Of Structures, Part 1 General provisions and buildings, (Fifth Revision).
5. Richards, G., "Warehouse Management: A complete guide to improving efficiency and minimizing costs in the modern warehouse", London Philadelphia, 2011.
6. Tompkins, J.A., and Smith, J.D., "The Warehouse Management Handbook", Tompkins press, 1998.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		3	1		
CO2	1		3	1		
CO3	1		3	1		
CO4	1		3	1		
CO5	1		3	1		
Avg	(5/5)=1		(15/5)=3	(5/5)=1		

MR4071 INTERNET OF THINGS FOR MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To understand the basics of IoT, Opportunities and challenges in IoT
2. To design a IoT solution
3. To develop an IoT protype
4. To explain the various protocols used in IoT and Localization
5. To examine the applications of IoT in Manufacturing

UNIT I INTRODUCTION 9

Technology of the IoT and applications,. IoT data management requirements, Architecture of IoT, Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things.

UNIT II DESIGN OF IoT 9

Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

UNIT III PROTOTYPING OF IoT 9

Design principles for connected devices -Embedded devices, physical design, online components, embedded coding system. Informed Manufacturing plant – Elements, IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Management of critical assets, Energy management and resource optimization, proactive maintenance.

UNIT IV PREREQUISITES FOR IoT 9

IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems

UNIT V APPLICATION IN MANUFACTURING 9

Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges

TOTAL : 45 PERIODS

OUTCOMES:

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

CO1: Identify the Opportunities and challenges in IoT
CO2: Propose a suitable IoT design
CO3: Develop an optimized IoT protype
CO4: Understand the various protocols used in IoT and Localization
CO5: Understand the applications of IoT in Manufacturing

REFERENCES:

1. Adrian McEwan and Hakim Cassimally, “Designing the internet of things”, Wiley, 2013
2. Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business, by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley & Sons.
3. Internet of Things: A Hands-On Approach by Vijay Madisetti, Arshdeep Bahga, VPT; 1st edition 2014.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, “From Machine-to-Machine to the Internet of Things -Introduction to a New Age of Intelligence” Elsevier
5. Meta Products -Building the Internet of Things by Wimer Hazenberg, Menno Huisman, BIS Publishers 2014.

CO	**PO**					
	1	2	3	4	5	6
1	1		2	1		
2	1		2			3
3	1		2			3
4	1		2			3
5	1		2			3
Avg	**(5/5)=1**		**(10/5)=2**	**(1/1)=1**		**(12/4)=3**

IS4071 DATA ANALYTICS

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES:

1. Recognize the importance of data analytics
2. Exhibit competence on data analytics packages
3. Apply solution methodologies for industrial problems.

UNIT I INTRODUCTION 9

Introduction to Multivariate Statistics-Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.

UNIT II MULTIPLE REGRESSION 9

Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).

UNIT III LOGISTIC REGRESSION 9

Regression with binary dependent variable -Simple Discriminant Analysis Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).

UNIT IV PRINCIPAL COMPONENT ANALYSIS 9

Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).

UNIT V 9

Latent Variable Models an Introduction to Factor, Path, and Structural Equation Analysis- Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

- To recognize the importance of data analytics
- To Exhibit competence on data analytics packages
- To apply solution methodologies for industrial problems.

REFERENCES:

1. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. “Multivariate data analysis”, (7th edition). Pearson India. 2015
2. Tabachnick, B. G., & Fidell, L. S., “Using multivariate statistics”, (5th edition). Pearson Prentice Hall, 2001
3. Gujarati, D. N. , “Basic econometrics”, Tata McGraw-Hill Education, 2012
4. Malhotra, N. K., “ Marketing research: An applied orientation”, 5/e. Pearson Education India, 2008
5. Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. “ Applied multiple regression/correlation analysis for the behavioral sciences”, Routledge., 2013
6. Han, J., Kamber, M., & Pei, J. “Data mining: concepts and techniques: concepts and techniques”, Elsevier, 2011.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
AVG	1	1	1	1	1	1

1-low, 2-medium, 3-high, ‘-“- no correlation

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

COURSE OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

COUSE OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 –Learn about what to write in each section
CO3 –Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION **6**

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS **6**

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA **6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT **6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT **6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep& Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company, 2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi, 2001.

AX4093 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

- The Constitution of India,1950(Bare Act),Government Publication.
- Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094 **நற்றமிழ் இலக்கியம்** **L T P C**
2 0 0 0

UNIT I சங்க இலக்கியம் **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II அறநெறித் தமிழ் **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல் அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III இரட்டைக் காப்பியங்கள் **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV அருள்நெறித் தமிழ் **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

UNIT V நவீன தமிழ் இலக்கியம் 6

1. உரைநடைத் தமிழ்,
- தமிழின் முதல் புதினம்,
- தமிழின் முதல் சிறுகதை,
- கட்டுரை இலக்கியம்,
- பயண இலக்கியம்,
- நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
27.	OCE431	Integrated Water Resources Management	3	0	0	3
28.	OCE432	Water, Sanitation and Health	3	0	0	3
29.	OCE433	Principles of Sustainable Development	3	0	0	3
30.	OCE434	Environmental Impact Assessment	3	0	0	3
31.	OIC431	Blockchain Technologies	3	0	0	3
32.	OIC432	Deep Learning	3	0	0	3
33.	OBA431	Sustainable Management	3	0	0	3
34.	OBA432	Micro and Small Business Management	3	0	0	3
35.	OBA433	Intellectual Property Rights	3	0	0	3
36.	OBA434	Ethical Management	3	0	0	3
37.	ET4251	IoT for Smart Systems	3	0	0	3
38.	ET4072	Machine Learning and Deep Learning	3	0	0	3
39.	PX4012	Renewable Energy Technology	3	0	0	3
40.	PS4093	Smart Grid	3	0	0	3
41.	CP4391	Security Practices	3	0	0	3
42.	MP4251	Cloud Computing Technologies	3	0	0	3
43.	IF4072	Design Thinking	3	0	0	3
44.	MU4153	Principles of Multimedia	3	0	0	3
45.	DS4015	Big Data Analytics	3	0	0	3
46.	NC4201	Internet of Things and Cloud	3	0	0	3
47.	MX4073	Medical Robotics	3	0	0	3
48.	VE4202	Embedded Automation	3	0	0	3
49.	CX4016	Environmental Sustainability	3	0	0	3
50.	TX4092	Textile Reinforced Composites	3	0	0	3
51.	NT4002	Nanocomposite Materials	3	0	0	3

52.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

OCE431 INTEGRATED WATER RESOURCES MANAGEMENT L T P C

3 0 0 3

OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM 9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS 9

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS 9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1	Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2	Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3	Apply law and governance in the context of IWRM.
CO4	Discuss the linkages between water-health; develop a HIA framework.
CO5	Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.

2. Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.

4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.

5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

CO – PO Mapping - INTEGRATED WATER RESOURCES MANAGEMENT

POs/PSOs		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	2	2	2	2	2
PO2	Problem analysis	1	3	2	2	2	2
PO3	Design / development of solutions		2	2	2	2	2
PO4	Investigation	1	2			1	1
PO5	Modern Tool Usage	1	1	2	1	1	1
PO6	Individual and Team work		2	2			2
PO7	Communication		2	2			2
PO8	Engineer and Society	2	2	3	2	3	3
PO9	Ethics		2	3	2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance	1	1	1		1	1
PO12	Life Long Learning		2	2	2	2	2
PSO1	Knowledge of field research methodology, gender, legal and environmental aspects in the context of integrated water resources management	3	2	2	2	2	2
PSO2	Formulate, analyze and comprehend the differences in social and environmental variability in South Indian context with their peers and strive to work towards sustainability	2	2	2	2	2	2
PSO3	Produce and publish professional reports, peer-reviewed journal, on contemporary and state of the art research in integrated water resources management	2	2	2	2	2	2

OCE432 WATER, SANITATION AND HEALTH L T P C

3 0 0 3

OBJECTIVES:

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario - Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure-Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE 9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

OUTCOMES:

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, “Basic Epidemiology”, 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda

3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary*. Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

CO PO MAPPING : WATER, SANITATION AND HEALTH

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		1	1	M	1	1
PO2	Problem analysis		2	2	2	2	2
PO3	Design / development of solutions			2	1	2	2
PO4	Investigation		2	3	3	3	3
PO5	Modern Tool Usage				1		1
PO6	Individual and Team work		2	2	1	2	2
PO7	Communication				2	2	2
PO8	Engineer and Society		3	3	3	3	3
PO9	Ethics			1	2	2	2
PO10	Environment and Sustainability		3			3	3
PO11	Project Management and Finance					1	1
PO12	Life Long Learning	2	3	2	3	3	3
PSO1	Explain the concepts of water management, field research methodology, gender, legal and environmental aspects in the context of integrated water resources management		3	3	3	3	3
PSO2	Formulate, analyse and comprehend the differences in social and economic variability in South Asian context with their peers and strive to work towards sustainability.		3	2	3	3	3
PSO3	Produce and publish professional reports, peer reviewed journal on contemporary and state of art research in water resources Engineering.		3	3	3	2	3

OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C

3 0 0 3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development- millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step- peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice**-** Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development – Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla,* IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.

CO – PO Mapping –Principles of Sustainable Development

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences						
PO2	Problem analysis	3	3				3
PO3	Design / development of solutions				3	3	3
PO4	Investigation		2	2	2	2	2
PO5	Modern Tool Usage						
PO6	Individual and Team work		2	2			2
PO7	Communication					1	1
PO8	Engineer and Society	3			3		3
PO9	Ethics				2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3

PO11	Project Management and Finance						
PO12	Life Long Learning					1	1
PSO1	Knowledge of Environmental Management discipline	3	3	3	3		3
PSO2	Environmental Performance Evaluation and coordination						
PSO3	Conceptualization of Environmental Management Systems						

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C

3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION 9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION 10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological –— cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

CO – PO Mapping- ENVIRONMENTAL IMPACT ASSESSMENT

PO/PSO		Course Outcome					Overall Correlation of COs to Pos
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		3			3	3
PO2	Problem analysis		2	2			2
PO3	Design / development of solutions		3	3	3		3
PO4	Investigation		2	2		2	2
PO5	Modern Tool Usage		2	2	3		2

PO6	Individual and Team work		2	2	2		2
PO7	Communication				1		1
PO8	Engineer and Society	2			2		2
PO9	Ethics	3	3	3	2	2	3
PO10	Environment and Sustainability	3			2		2
PO11	Project Management and Finance				1		L
PO12	Life Long Learning		1	1			L
PSO1	Knowledge of Environmental Engineering discipline	2					2
PSO2	Environmental Performance Evaluation and coordination		2	2	2		2
PSO3	Conceptualization of Environmental Engineering Systems		2		2		2

OIC431 BLOCKCHAIN TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	2	1	3	2	2	3
2	2	1	2	3	2	2
3	2	1	3	1	2	1
4	2	1	2	3	2	2
5						
Avg	2.00	1.00	2.50	2.25	2.00	2.00

OIC432 **DEEP LEARNING** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS **6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data.

Video Data.

UNIT II NEURAL NETWORKS **9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK **10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT VI NATURAL LANGUAGE PROCESSING USING RNN **10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING **10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data

CO2: Implement Image Segmentation and Instance Segmentation in Images

CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)

CO4: Traffic Information analysis using Twitter Data

CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner’s Approach Josh Patterson and Adam Gibson O’Reilly Media,

Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OBA431 SUSTAINABLE MANAGEMENT LT P C

3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.

CO2: An understanding of corporate sustainability and responsible Business Practices

CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.

CO4: Knowledge of innovative practices in sustainable business and community management

CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

MAPPING OF POs AND COs:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	2	2
CO2	3	2	2	2	1	2
CO3	3	3	1	2	2	3
CO4	3	3	2	1	1	2
CO5	3	3	2	1	2	2

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1. Familiarise the students with the concept of small business

CO2. In depth knowledge on small business opportunities and challenges

CO3. Ability to devise plans for small business by building the right skills and marketing strategies

CO4. Identify the funding source for small start ups

CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). “The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000.” Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). “Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia.” Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME’s.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	-	-
CO2	3	3	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	2	2	1	1
CO5	3	2	2	3	2	1

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C

3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS **9**

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2	3	3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	2	3

OBA434 ETHICAL MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY 9

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations-Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology- ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2		3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3

CO5	3	3	3	2	2	3

ET4251 **IoT FOR SMART SYSTEMS** **LT P C**

3 0 0 3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES **9**

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

CO	PO					
	1	2	3	4	5	6
1	1	2	1	-	-	-
2	-	2	-	-	-	-
3	1	2	-	1	3	-
4	2		3	3	3	3
5	3	2	3	3	3	3
Avg.	1.75	2	2.33	2.33	3	2

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.

9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072 MACHINE LEARNING AND DEEP LEARNING L T P C

3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS **9** Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS **9**

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS **9**

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS **9** Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS **9** State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	3	1	-	-	-
2	2	3	2	-	-	-
3	3	-	3	-	3	-
4	2	3	3	-	-	-
5	3	3	3	-	3	-
6	3	3	3	-	3	-
7	3	3	3	-	3	-
Avg.	2.42	3	2.57	-	3	-

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning

2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN:

   9780262035613, 2016.

3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.

4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.

5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9

Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO_2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:

After completion of this course, the student will be able to:

CO1: Demonstrate the need for renewable energy sources.

CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.

CO3: Design a stand-alone and Grid connected PV system.

CO4: Analyze the different configurations of the wind energy conversion systems.

CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford UniversityPress, 2009.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006
6. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	2	2	1
CO2	3		2	3	3	3
CO3	3		2	3	3	3
CO4	3		2	3	3	2
CO5	3		2	2	2	2

PS4093 **SMART GRID** **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.

- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.

CO2: Explain the function of Smart Grid.

CO3: Experiment the issues of Power Quality in Smart Grid.

CO4: Analyze the performance of Smart Grid.

CO5**:** Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

MAPPING OF CO'S WITH PO'S

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	-	2	2	2
2	3	-	2	2	-	2
3	2	-	1	-	-	-
4	1	-	-	3	3	1
5	-	2	2	2	2	3
AVG	2.25	2	1.66	2.25	2.3	2

CP4391 SECURITY PRACTICES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	1	2	1	1	2	1
2	2	1	3	1	1	2
3			2	3	3	3
4	2	2	1	2	1	3
5	1		1	1	2	3
Avg	1.50	1.67	1.60	1.60	1.80	2.40

MP4251 **CLOUD COMPUTING TECHNOLOGIES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization –– Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner‟s Guide‖, McGraw-Hill Osborne Media, 2009.

6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072 **DESIGN THINKING** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I **UX LIFECYCLE TEMPLATE** **8**

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II **CONTEXTUAL INQUIRY** **10**

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III **DESIGN THINKING, IDEATION, AND SKETCHING** **9**

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV **UX GOALS, METRICS, AND TARGETS** **8**

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and

cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product

2: Defining the Look and Feel of any new Project

3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)

4: Identify a customer problem to solve.

5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Build UI for user Applications

CO2: Use the UI Interaction behaviors and principles

CO3: Evaluate UX design of any product or application

CO4: Demonstrate UX Skills in product development

CO5: Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 PRINCIPLES OF MULTIMEDIA L T P C

3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION 9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA 9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS 9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.

2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS 9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Handle the multimedia elements effectively.

CO2: Articulate the concepts and techniques used in multimedia applications.

CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.

CO4: Design and implement algorithms and techniques applied to multimedia objects.

CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.

2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

DS4015 **BIG DATA ANALYTICS** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I **INTRODUCTION TO BIG DATA** **9**

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II **SEARCH METHODS AND VISUALIZATION** **9**

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies – Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III **MINING DATA STREAMS** **9**

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing -Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV **FRAMEWORKS** **9**

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V **R LANGUAGE** **9**

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1:understand the basics of big data analytics

CO2: Ability to use Hadoop, Map Reduce Framework.

CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.

CO4:gain knowledge on R language

CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	2	1
2	3	3	3	3	2	1
3	3	3	3	3	2	1
4	3	3	3	3	2	1
5	3	3	3	3	2	1
Avg	3	3	3	3	2	1

NC4201 INTERNET OF THINGS AND CLOUD L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT 9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT 9

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION 9

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD 9

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core - Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: Understand the various concept of the IoT and their technologies..

CO2: Develop IoT application using different hardware platforms

CO3: Implement the various IoT Protocols

CO4: Understand the basic principles of cloud computing.

CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
4. Simon Walkowiak, "Big Data Analytics with R" PackT Publishers, 2016
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.

MX4073 MEDICAL ROBOTICS L T P C

3 0 0 3

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators

CO2: Explain the functions of manipulators and basic kinematics

CO3: Describe the application of robots in various surgeries

CO4: Design and analyze the robotic systems for rehabilitation

CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

CO-PO Mapping

CO	POs

	PO1	PO2	PO3	PO4	PO5	PO6
1				1		
2				2		
3	2		2	2	2	2
4	2		2	2	3	2
5	2		2	2	3	3
Avg	**2**		**2**	**1.8**	**2.6**	**2.3**

VE4202 EMBEDDED AUTOMATION L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS

9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT – V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor -Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details

CO2: write embedded C programs for embedded system application

CO3: design and develop real time systems using AVR microcontrollers

CO4: design and develop the systems based on vision mechanism

CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1		1	1	1	
2	1	3	1	1	1	3
3	1	3	1	1	1	3
4	1	3	1	1	1	3
5	1	3	1	1	1	3
Avg	(5/5)=1	(12/4)=3	(5/5)=1	(5/5)=1	(5/5)=1	(12/4)=3

CX4016	ENVIRONMENTAL SUSTAINABILITY	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION **9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II CONCEPT OF SUSTAINABILITY **9**

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY **9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS **9**

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS **9**

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092 **TEXTILE REINFORCED COMPOSITES** **L T P C**

3 0 0 3

UNIT I REINFORCEMENTS 9

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES 9

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING 9

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING 9

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS 9

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang,“Advanced Polymer composites”,ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., “Experimental Characterization of advanced composite Materials”,SecondEdition,CRCPress,NewJersey,1996.
3. George LubinandStanley T.Peters, “Handbook of Composites”, Springer Publications,1998.
4. Mel. M. Schwartz, “Composite Materials”, Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.
5. RichardM.Christensen,“Mechanics of compositematerials”,DoverPublications,2005.
6. Sanjay K. Mazumdar, “Composites Manufacturing: Materials, Product, and Process Engineering”,CRCPress,2001

NT4002 **NANOCOMPOSITE MATERIALS** **L T P C**

3 0 0 3

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal- Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999

6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C

3 0 0 3

UNIT I IPR 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY 9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS 9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large

units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.

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