ANNAMALAI UNIVERSITY

Annamalainagar

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MANUFACTURING ENGINEERING

B.E. Mechanical Engineering (Manufacturing)

Choice Based Credit System

HAND BOOK

2018

DEPARTMENT OF MANUFACTURING ENGINEERING

VISION

Provide high quality education to create technically competent manufacturing engineers to strive hard for the sustainable development of industry and society and to serve for the nation building.

MISSION

- Develop the student community with wider knowledge in the emerging fields of Mechanical Engineering with more emphasis on Manufacturing Engineering.

- Inculcate innovative skills, research aptitude, team work, ethical practices among students so as to meet the expectations of the industry as well as society.

- Motivate the students to pursue higher education and take competitive examinations and various career enhancing program.

- Create a conducive and supportive environment for all round growth of the students,
- faculty & staff with emphasis on life-long learning.

- Provide quality education by periodically updating curriculum, effective teaching-learning process, best laboratory facilities and collaborative ventures with the industries.

PROGRAMME EDUCATIONAL OBJECTIVES

1. The graduates acquire ability to create model, design, synthesize and analyze essential production operational skills, mechanism and automation system.

2. The graduates use their talent, self-confidence, knowledge and engineering practice which facilitate them to presume position of scientific and/or managerial leadership in their career paths.

3. The graduates will adopt ethical attitude and exhibit effective skills in communication management team work and leader qualities.

4. The graduates apply their consciousness of moral, professional responsibilities and motivation to practice life-long learning in a team work environment.

B.E. MECHANICAL ENGINEERING (MANUFACTURING)

PROGRAM OUTCOMES

After the successful completion of the B.E. Mechanical Engineering (Manufacturing) degree programme, the students will be able to:

PO1: INTEGRATION OF KNOWLEDGE

Demonstrate strong basics in mathematics, science, engineering and technology which serve as the foundation for the Programme.

PO2: PROBLEM ANALYSIS

Demonstrate the ability to design and conduct experiments, as well as to analyze and interpret data in the spheres of fundamental engineering.

PO3: DESIGN AND DEVELOPMENT OF SOLUTIONS

Demonstrate the ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

PO4: USE OF MODERN TOOLS AND TECHNIQUES

Become familiar with modern engineering tools and analyse the problems within the domains of Manufacturing Technology as the members of multidisciplinary teams

PO5: COLLABORATIVE AND MULTIDISCIPLINARY APPROACH

Acquire the capability to identify, formulate and solve engineering problems related to manufacturing engineering in interdisciplinary and multidisciplinary sciences

PO6: ETHICAL PRACTICES AND SOCIAL RESPONSIBILITIES

Demonstrate an understanding of professional and ethical responsibility with reference to their career in the field of manufacturing engineering.

PO7: COMMUNICATION SKILLS

Interact with engineering community and with society at large, regarding intricate engineering activities on technical perspectives and emerge as an efficient motivator. He will be able to communicate effectively both in verbal and non verbal forms.

PO8: PROJECT MANAGEMENT

Design and develop innovative / manufacturable / marketable/ environmental friendly products useful to the society and nation at large. Graduate will be able to manage any organization well and will be able to emerge as a successful entrepreneur

PO9: LIFE LONG LEARNING

Understand the value for life long-long learning, in the context of technological challenges.

PO10: ENVIRONMENT AND SUSTAINABLITY

Acquire ample knowledge essential for sustainable development in consideration of environmental impacts and contemporary issues.

PO11: SOCIAL RESPONSIBILITY

Understand the nature of profession and be vigilant in order to maximize the chances of a positive contribution to society.

PO12: INVESTIGATION OF COMPLEX PROBLEM

Perform investigations, design and conduct experiments, analyze and interpret the results to provide valid conclusion.

Mapping PO with PEO												
POs/ PEOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
PEO1	✓	✓	✓	✓	✓			✓				✓
PEO2			✓	✓	✓	✓	✓	✓		✓	✓	✓
PEO3						✓	✓	✓		✓		
PEO4			✓	✓		✓	✓		✓		✓	

COURSES AND CREDITS - SUMMARY

Semester	No. of Courses		HS	BS	ES	PC	PE	OE	S&IT	Proj.	Total Credit
	T+P	Total									
I	3+3	**6**	-	9.5	8	-	-	-	-	-	17.5
			-	3	3						
II	4+3	**7**	3	9.5	8	-	-	-	-	-	20.5
			1	3	3						
III	6+3	**9**	-	4	9.5	10	-	-	4	-	27.5
			-	1	4	4					
IV	6+3	**9**	-	3	2	16.5	-	-	-	-	21.5
				1	1	7					
V	6+3	**9**	-	-	-	16.5	6	-	4	-	26.5
						7	2				
VI	6+2	**8**	-	-	-	9	9	3	-	-	21
						4	3	1			
VII	5+2+1	**8**	2	-	-	4.5	6	3	4	-	19.5
			1			2	2	1	1		
VIII	2+0+1	**3**	-	-	-	-	-	6	-	6	12
								2	-	1	
Total Courses	**38+20 +2**	**60**	**2**	**8**	**11**	**24**	**7**	**4**	**1**	**1**	**-**
Total credits		**-**	**5**	**26**	**27.5**	**56.5**	**21**	**12**	**2**	**10**	**166**

DETAILS OF COURSE CODE

S. No.	Code	Branch	S. No.	Code	Branch
1.	CH	Chemical Engineering	6.	EC	Electronics & Communication Engg
2.	CE	Civil Engineering	7.	EI	Electronics & Instrumentation Engg
3.	CS	Computer Science & Engg	8.	IT	Information Technology
4.	CZ	Civil & Structural Engineering	9.	ME	Mechanical Engineering
5.	EE	Electrical & Electronics Engg.	10.	MM	Mechanical Engg. (Manufacturing)

S. No.	Code	Category	S. No.	Code	Category
1	HS	Humanities	6	PE	Professional Elective Theory
2	BS	Basic Science	7	OE	Open Elective Theory
3	ES	Engineering Science	8	PV	Project work Viva-voce
4	PC	Professional Core Theory	9	ST	Seminar & Industrial Training
5	CP	Professional Core Practical			

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MANUFACTURING ENGINEERING

COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATION -2018)

SEMESTER I									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
ETBS101	**BS-I**	Physics	3	1	0	25	75	100	4
ETBS102	**BS-II**	Mathematics – I	3	1	0	25	75	100	4
ETES103	**ES-I**	Basic Electrical Engineering	3	1	0	25	75	100	4
ETBP104	**BSP-I**	Physics Laboratory	0	0	3	40	60	100	1.5
ETSP105	**ESP-I**	Electrical Engineering Laboratory	0	0	2	40	60	100	1
ETSP106	**ESP-II**	Engineering Graphics and Design	1	0	4	40	60	100	3
						Total Credits			**17.5**

SEMESTER II									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
ETHS201	**HS-I**	English	2	0	0	25	75	100	2
ETBS202	**BS-III**	Chemistry	3	1	0	25	75	100	4
ETES203	**ES-II**	Programming for Problem Solving	3	0	0	25	75	100	3
ETBS204	**BS-IV**	Mathematics – II	3	1	0	25	75	100	4
ETHP205	**HSP-I**	Communication Skills and Language Laboratory	0	0	2	40	60	100	1
ETBP206	**BSP-II**	Chemistry Laboratory	0	0	3	40	60	100	1.5
ETSP207	**ESP-III**	Computer Programming Lab	0	0	4	40	60	100	2
ETSP208	**ESP-IV**	Engineering Workshop/ Manufacturing Practices	1	0	4	40	60	100	3
						Total Credits			**20.5**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming III Semester.									

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MANUFACTURING ENGINEERING

COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATION -2018)

SEMESTER III

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
ETBS301	**BS-V**	Engineering Mathematics III	3	1	-	25	75	100	4
ETES302	**ES-III**	Environmental Studies	3	-	-	25	75	100	3
ETES303	**ES-IV**	Engineering Mechanics	3	-	-	25	75	100	3
MMES304	**ES-V**	Thermal Engineering	2	-	-	25	75	100	2
MMPC305	**PC-I**	Machine Tool Technology	3	-	-	25	75	100	3
MMPC306	**PC-II**	Engineering Metrology	3	1	-	25	75	100	4
MMSP307	**ESP-V**	Thermodynamics Lab	-	-	3	40	60	100	1.5
MMCP308	**PCP-I**	Machine Tool Lab	-	-	3	40	60	100	1.5
MMCP309	**PCP-II**	Metrology Lab	-	-	3	40	60	100	1.5
ETIT310	**IT-I**	Internship Inter/ Intra Institutional Activities*	***Four** weeks during the summer vacation at the end of **II Semester***				100	100	**4.0**
***For the **Lateral entry students** total credit for III Semester is **23.5** as they are exempted from internship during summer vacation of II semester.*							**Total Credits**		**27.5**

SEMESTER IV

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
EEBS401	**BS-VI**	Probability, Random Process and Numerical Methods	3	-	-	25	75	100	3
MMES402	**ES-VI**	Material Science	2	-	-	25	75	100	2
MMPC403	**PC-III**	Kinematics and Dynamics of Machinery	3	-	-	25	75	100	3
MMPC404	**PC-IV**	Metal Joining Processes	3	-	-	25	75	100	3
MMPC405	**PC-V**	Metal Machining Processes	3	-	-	25	75	100	3
MMPC406	**PC-VI**	Industrial Management & Engineering	3	-	-	25	75	100	3
MMCP407	**PCP-III**	Dynamics lab	-	-	3	40	60	100	1.5
MMCP408	**PCP-IV**	Metal Joining Lab	-	-	3	40	60	100	1.5
MMCP409	**PCP-V**	Metal Machining Lab	-	-	3	40	60	100	1.5
						Total Credits			**21.5**

Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming V Semester.

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MANUFACTURING ENGINEERING

COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATION -2018)

SEMESTER V									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
MMPC501	**PC-VII**	Casting Technology	3	-	-	25	75	100	3
MMPC502	**PC-VIII**	Metal Forming Processes	3	-	-	25	75	100	3
MMPC503	**PC-IX**	Engineering Metallurgy	3	-	-	25	75	100	3
MMPC504	**PC-X**	Mechanics of Materials	3	-	-	25	75	100	3
MMPE505	**PE-I**	Professional Elective - I	3	-	-	25	75	100	3
MMPE506	**PE-II**	Professional Elective - II	3	-	-	25	75	100	3
MMCP507	**PCP-VI**	Metal Forming Lab	-	-	3	40	60	100	1.5
MMCP508	**PCP-VII**	Metallurgy Lab	-	-	3	40	60	100	1.5
MMCP509	**PCP-VIII**	Strength of Materials Lab	-	-	3	40	60	100	1.5
ETIT510	**IT-II**	Industrial Training / Rural Internship/Innovation / Entrepreneurship	***Four** weeks during the summer vacation at the end of **IV Semester***				100	100	**4.0**
						Total Credits			**26.5**

SEMESTER VI									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
MMPC601	**PC-XI**	Mechatronics	3	-	-	25	75	100	3
MMPC602	**PC-XII**	Fluid Mechanics & Machinery	3	-	-	25	75	100	3
MMPE603	**PE-III**	Professional Elective - III	3	-	-	25	75	100	3
MMPE604	**PE-IV**	Professional Elective - IV	3	-	-	25	75	100	3
MMPE605	**PE-V**	Professional Elective - V	3	-	-	25	75	100	3
*YYOE606	**OE-I**	Open Elective – I (Inter department, FEAT)	3	-	-	25	75	100	3
MMCP607	**PCP-IX**	Design & Automation Lab (CAD/CAM)	-	-	3	40	60	100	1.5
MMCP608	**PCP-X**	Hydraulics Lab	-	-	3	40	60	100	1.5
						Total Credits			**21**

Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming VII Semester.

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MANUFACTURING ENGINEERING

COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATION -2018)

SEMESTER VII									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
ETHS701	**HS-II**	Engineering Ethics	3	-	-	25	75	100	2
MMPC702	**PC-XIII**	Design of Machine Elements	3	-	-	25	75	100	3
MMPE703	**PE-VI**	Professional Elective - VI	3	-	-	25	75	100	3
MMPE704	**PE-VII**	Professional Elective - VII	3	-	-	25	75	100	3
YYOE705	**OE-II**	Open Elective – II (Inter department, Allied)	3	-	-	25	75	100	3
MMCP706	**PCP- XI**	Machine Drawing	-	-	3	40	60	100	1.5
ETIT707	**IT-III**	Industrial Training / Rural Internship/Innovation / Entrepreneurship	***Four** weeks during the summer vacation at the end of **VI Semester***				100	100	**4.0**
						Total Credits			**19.5**

SEMESTER VIII									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
MMOE801	**OE-III**	Open Elective - III	3	-	-	25	75	100	3
MMOE802	**OE-IV**	Open Elective - IV	3	-	-	25	75	100	3
MMPV803	**PV-I**	Project Work and Viva-voce	-	PR 10	S 2	40	60	100	6
						Total Credits			**12**

L	No. of Lecture Hours	**TR**	No. of Hours for Discussion on Industrial Training
T	No. of Tutorial Hours	**S**	No. of Seminar Hours on Industrial Training / Project
P	No. of Practical Hours	**PR**	No. of Hours for Discussion on Project work
CA	Continuous Assessment Marks	**FE**	Final Examination Marks
Credits	Credit points allotted to that course	**Total**	Total Marks

PE-PROFESSIONAL ELECTIVES

1. MMPESCN Non-Traditional Manufacturing Processes
2. MMPESCN Tool Engineering
3. MMPESCN Computer Integrated Manufacturing Systems
4. MMPESCN Computer Aided Product Design
5. MMPESCN Production & Operation Management
6. MMPESCN Total Quality Management
7. MMPESCN Advanced Manufacturing processes
8. MMPESCN Non-Destructive Testing

OE-OPEN ELECTIVES

1. MMOESCN Operations Research
2. MMOESCN Machine Tool Design
3. MMOESCN Neural Network and Fuzzy Logic
4. MMOESCN Maintenance and Safety Engineering
5. MMOESCN Engineering Economics
6. MMOESCN Sensors and Control Systems in Manufacturing
7. MMOESCN Surface Engineering
8. MMOESCN Precision Engineering and Nano-Technology
9. MMOESCN Composite Materials
10. MMOESCN Supply Chain Management

HONOURS ELECTIVES

			Credits
1.	MMHESCN	Mechanical Behaviour of Materials	4
2.	MMHESCN	Composite Materials	3
3.	MMHESCN	Modern Manufacturing Strategies	3
4.	MMHESCN	Robotics and Automations	4
5.	MMHESCN	Plant Layout and Material Handling	3
6.	MMHESCN	Maintenance Management	3

MINOR ENGINEERING ELECTIVES

			Credits
1.	MMMISCN	Machine Tools and Metal Cutting	4
2.	MMMISCN	Metal Casting, Forming and Joining Processes	4
3.	MMMISCN	Total Quality Management	3
4.	MMMISCN	Computer Integrated Manufacturing Systems	3
5.	MMMISCN	Engineering Metrology	3
6.	MMMISCN	Non-Destructive Testing	3

SYLLABUS
FIRST SEMESTER

Course code	**ETBS101**				
Category	Basic Science Course				
Course title	**PHYSICS**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	3	**1**	**0**	**4**	

Course Objectives

- To understand the ray of light to undergo the phenomenon of interference diffraction and polarization.
- To understand the principle and various application of laser.
- To develop knowledge in crystal structure and its properties.
- To understand the energy quantization of subatomic particles like electron.
- Rationalize the law of conservation of energy in solar water heater and solar cells.

Unit - I. Wave optics (9 Lectures)

Huygens' Principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer and Mach-Zehnder interferometer. Fraunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; diffraction gratings and their resolving power

Unit - II. Lasers (8 Lectures)

Introduction – Principles of Laser – Stimulated emission, Properties of laser beams: mono-chromaticity, coherence, directionality and brightness Einstein's theory of, stimulated emission A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO_2), solid- state lasers (ruby, Neodymium), dye lasers, laser speckles, applications of lasers in science, engineering and medicine.

Unit - III. Crystal Physics (7 Lectures)

Introduction to solid Materials – crystal structure – Geometry of lattice unit cell – Bravais' lattice – crystal systems, Crystal structures of Materials –(Cordination number, Atomic radius, packing factor and packing density) – Types of crystal Lattice (Simple Cubic, Body Centered Cubic, Face Centered Cubic and Hexagonal Closed Packed) Miller Indices and their calculations - Finding Miller indices of crystal planes.

Unit - IV. Quantum Mechanics (8 Lectures)

Heisenberg uncertainity Principle –Dual nature of Matter and radiation – De Broglie's Wave length – wave Velocity and group velocity. The wave Equation, Schrödinger's time dependent and independent wave equations - The Wave function and its physical significance - The particle in a box Problem (one dimensional box) - energy quantization – Eigen values and Eigen functions.

Unit - V. Energy Physics (8 Lectures)

Introduction to energy sources - Energy sources and their availability (Conventional and Non- conventional energy sources) solar energy – Methods of Harvesting solar energy – Solar heat collector, solar water heater and solar cells. Wind energy – basic principle and components of wind energy Conversion system (WECS) – application of wind energy. Biomass - Biogas Generation - Classification of Biogas plants –Properties and application of Biogas.

Text Books

1. Arumugam.M. "Engineering Physics", Anuradha agencies, 2nd Edition, 1997.
2. John Twidell & Tony Weir, " Renewable Energy Resources" , Taylor & Francis, 2005.
3. Avadhanulu. M.N. and Kshirsagar P.G., "A Text Book of Engineering Physics", S. Chand & Company Ltd., 7th Enlarged Revised Ed., 2005.
4. Gaur R.K. and Gupta S.L., "Engineering Physics", Dhanpat Rai Publishers, New Delhi, 2003.
5. Rai.G.D. , *"Solar Energy* Utilization" Volume-1 & 2 by - Khanna Publishers, New Delhi.
6. Pajput. R. K. Non – Conventional energy sources and Utilization - S . Chand Publication – 2013.

Reference Books

1. Rajendran.V , "Engineering Physics", Tata McGraw Hill publishers, 2009.
2. Rai G.D., "Non-conventional Energy sources", Khauna Publications, 1993.
3. Mani. P. "Engineering Physics", Dhanam Publication, Chennai, 2011.
4. Agarwal.M.P, "Solar Energy", S.Chand & Co., I Edn, New Delhi, 1983.

Course Outcomes

- To understand the ray of light to undergo the phenomenon of interference diffraction and polarization.
- To understand the principle and various application of laser.
- To develop knowledge in crystal structure and its properties.
- To explain the fundamental terms in crystallography.
- To discuss Miller indices in crystal plans and their applications.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓							

CO2	✓		✓	✓					✓			
CO3	✓	✓										
CO4	✓	✓										
CO5	✓								✓			

Course code	**ETBS102**				
Category	Basic Science Course				
Course title	**Mathematics - I**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	3	**1**	**0**	**4**	

Unit 1: Calculus: (6 lectures)

Evaluation of definite-integrals and their properties-Applications of definite integrals to evaluate surface areas and volumes of revolutions. Improper integral-Beta and Gamma functions and their properties.

Unit 2: Calculus: (6 lectures)

Rolle's theorem-Mean value theorem. Indeterminate forms-L'Hospital's rule. Functions of two variables: Taylor's and Maclaurin's series expansions-Maxima and minima for functions of two variables.

Unit 3: Sequences and series: (10 lectures)

Convergence of sequence and series-tests for convergence: Comparison test(only for series with positive terms)-D'Alembert's ratio test-Cauchy's root test-Integral test-Leibnitz's test(Alternating series).

Unit 4: Vector Calculus (Differentiation): (8 lectures)

Gradient, divergence and curl- directional derivative-unit normal vector-irrotational and solenoidal vectors-expansion formulae for operators involving ∇.

Unit 5: Matrices (10 lectures)

Rank of a matrix- Symmetric, skew-symmetric and orthogonal matrices-Characteristic equation- Eigen values and Eigen vectors - Cayley-Hamilton Theorem-Diagonalization of symmetric matrices by Orthogonal transformation.

Suggested Text/Reference Books

(i) G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

(ii) Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley &

Sons,
2006.

(iii) Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.

(iv) Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

(v) D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.

(vi) N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

(vii)B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Outcomes

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

The students will learn:

- To apply differential and integral calculus to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
- The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
- The tool of sequences and series for learning advanced Engineering Mathematics.
- To deal with vector calculus that are essential in most branches of engineering.
- The essential tool of matrices and linear algebra in a comprehensive manner.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓										
CO2	✓			✓	✓					✓		
CO3	✓	✓							✓			✓
CO4	✓	✓										
CO5	✓	✓	✓		✓							

Course Code	**ETES103**				
Category	Engineering Science Course				
Course Title	**Basic Electrical Engineering**				
Scheme and Credits	L	T	P	Credits	
	3	**1**	**0**	**4**	

Course Objectives:

- To understand the basic laws and theorems of electric circuits.
- To know the concept of AC and DC quantities.
- To understand the working of transformer.
- To know the operation and principles of electrical machines.
- To know the protective devices used in electrical installations.

Unit 1: DC Circuits (8 Hours)

Electrical circuit elements (R,L and C) -Voltage and Current sources - Kirchhoff Current and Voltage laws-Thevenin's theorem and Norton's theorem - Analysis of simple circuits with dc excitation.

Unit 2: AC Circuits (8 Hours)

Representation of sinusoidal waveforms:Peak, Average and RMS values -Voltage and Current relationship in R, L and C- Power, Power factor and Power triangle- Analysis of single-phase RL, RC and RLC ac circuits - Three phase balanced circuits: Voltage and Current relations in Star andDelta connections.

Unit 3: Transformers (6 Hours)

Single-phase Transformer: Construction and Working principle, EMF equation, Losses, regulation and efficiency-Three-phase transformer: Construction and Connections -Auto-transformer: Principle, Saving of Copper.

Unit 4: Electrical Machines (8 Hours)

DC Motor: Construction, Working principle, Types, Speed control and Application - Three-phase cage induction motor: Construction, Working principle - Single-phase induction motor:Types and Applications – Alternator:Construction and Working principle, EMF equation.

Unit 5: Electrical Installations and Power Converters (12 Hours)

Types of Wires and Cables – Introduction to protective devices: Switch Fuse Unit(SFU), MCB, ELCB, MCCB – Earthing:Pipe and Plate Earthing -PN Junction Diode – Silicon Controlled Rectifier (SCR) - Rectifiers.

Suggested Text/ Reference Books

(i) D.P.Kothari and I.J.Nagrath "Basic Electrical Engineering", Tata McGraw Hill, 2010.
(ii) D.C.Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
(iii)L.S.Borow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
(iv)E.Hughes, "Electrical and Electronics Technology", Pearson, 2010.

(v) V.D.Toro,"Electrical Engineering Fundamentals", Prentice Hall India, 1989.

Course Outcomes

- Able to understand and analyze the basic electric circuits.
- Acquire knowledge about the principles and operations of Transformers.
- Acquire knowledge about the principles and working of Electric generators and Motors.
- Able to understand the characteristics of SCR and process of rectification.
- Acquire knowledge about the components of low voltage electrical installations and safety practices.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓									
CO2	✓		✓	✓								
CO3	✓		✓	✓								
CO4				✓								
CO5				✓				✓	✓			

Course code	**ETBP104**				
Category	Basic Science Course				
Course title	**Physics Laboratory**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	0	**0**	**3**	**1.5**	

Objectives:

- To access the Rigidity modulus of wire.
- To assess the various properties of light.
- To asses the characterization of Metals.
- To analyses the thickness of microsized objects.

List of Experiments:

1. Air Wedge
2. Newtons's Rings
3. Simple Pendulum
4. Dispersive power of the Prism
5. Diffraction Grating
6. Acoustic diffraction Grating
7. Compound Pendulum
8. Kunt's tube experiment

9. Young's double slit experiment
10. Laser Grating
11. Torsional Pendulum
12. Young's Modulus – Non-uniform Bending
13. Young's Modulus – Uniform Bending.

Course outcomes:

- Understand the material characteristics of metals and insulators.
- Understand the usage of vernier caliper and screw gauge for the length measurement.
- To understand the torsional properties of metal wires.
- To understand the dispersion of light through prism.
- Make measurement of thickness of microsized object.
- To understand and measurement of wavelength of polychromatic source of light.

Mapping with Programme Outcomes.												
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓							✓
CO2					✓							
CO3	✓				✓							
CO4					✓							
CO5												
CO6	✓	✓	✓									✓

Course Code	**ETSP105**				
Category	Engineering Science Course				
Course Title	**Electrical Engineering Laboratory**				
Scheme and Credits	L	T	P	Credits	
	0	**0**	**2**	**1**	

List of experiments/ demonstrations:

- Basic safety precautions, Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
- Measuring the steady – state and transient time-response of R-L,R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L and R-C circuits – impedance calculation and verification. Observation of phase difference between current and voltage. Resonance in R-L-C circuits.
- Transformers: Observation of the no-load current waveform on an oscilloscope (non-sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonies. Loading of a transformer: measurement of primary and secondary voltages and currents and power.
- Three-phase transformers: Star and Delta connections, Voltage and Current relationships (line-line voltage, phase –to – neutral voltage, line and phase currents). Phase-shifts

between the primary and secondary sides. Cumulative three-phase power in balanced three-phase circuits.

- Demonstration of cut-out sections of machines: de machine (commutator -brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging – slip ring arrangement) and single–phase induction machine.
- Torque Speed Characteristic of separately excited de motor.
- Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super synchronous speed.
- Synchronous Machine operating as a generator: stand-alone operation with a load.
- Control of voltage through field excitation.
- Demonstration of (a) dc-dc convertors (b) dc-ac convertors – PWM waveform (c) the use of dc-ac convertor for speed control of an induction motor and (d) Components of LT switchgear

Laboratory Outcomes

- Get an exposure to common electrical components and their ratings.
- Make electrical connections by wires of appropriate ratings.
- Understand the usage of common electrical measuring instruments.
- Understand the basic characteristics of transformers and electrical machines.
- Get an exposure to the working of power electronic converters.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓									
CO2	✓		✓			✓						
CO3	✓		✓	✓								
CO4			✓	✓								
CO5			✓	✓								

Course code	**ETSP106**				
Category	Engineering Science Courses				
Course title	**Workshop / Manufacturing Practices**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	1	**0**	**4**	**3**	

(i) Lectures & Videos: (10 ours)

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 lectures)
2. CNC machining, Additive manufacturing (1 lecture)
3. Fitting operations & power tools (1 lecture)
4. Electrical & Electronics (1 lecture)

5. Carpentry (1 lecture)
6. Plastic molding, glass cutting (1 lecture)
7. Metal casting (1 lecture)
8. Welding (arc welding & gas welding), brazing (1 lecture)

Suggested Text/Reference Books:

(i) Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

(ii) Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology",
4th edition, Pearson Education India Edition, 2002.

(iii) Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson
Education, 2008.

(iv) Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.

(v) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House,
2017.

Course Outcomes

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

(ii) Workshop Practice: (60 hours)

1. Machine shop (10 hours)
2. Fitting shop (8 hours)
3. Carpentry (6 hours)
4. Electrical & Electronics(8 hours)
5. Welding shop (8 hours (Arc welding 4 hrs + gas welding 4 hrs)
6. Casting (8 hours)
7. Smithy (6 hours)
8. Plastic moulding & Glass Cutting (6 hours)

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Laboratory Outcomes

- Upon completion of this laboratory course, students will be able to fabricate components with their own hands.
- They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
- By assembling different components, they will be able to produce small devices of their interest.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		✓			✓	✓						
CO2	✓		✓	✓								
CO3				✓		✓						✓

SECOND SEMESTER

Course code	**ETHS201**				
Category	Humanities and Social Sciences including Management courses				
Course title	**English**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	2	**0**	**0**	**2**	

Module 1: **Vocabulary Building**

1.1 The concept of Word Formation
1.2 Root words from foreign languages and their use in English
1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Count and uncount nouns.
1.4 Synonyms, antonyms, and standard abbreviations.
1.5 Language development - Wh questions asking and answering yes or no questions.

Module 2:**. Basic Writing Skills**

2.1 Sentence Structures
2.2 Use of phrases and clauses in sentences
2.3 Importance of proper punctuation
2.4 Creating coherence and Techniques for writing precisely
2.5 Organizing principles of paragraphs in writing

Module 3: **Nature and Style of sensible Writing**

3.1 Describing and Defining
3.2 Classifying and Providing examples or evidence
3.3 Writing introduction and conclusion
3.4 Comprehension
3.5 Precis Writing

Module 4: **Writing Practices & Oral Communication**

4.1 Listening to lectures and making notes
4.2 Mechanics of presentation, asking and giving instruction
4.3 Essay Writing – Writing analytical essays and issue based essays.
4.4 Dialogue writing and conversation
4.5 Letter writing – Formal and informal

Module 5: **Group Discussion and Job Application**

5.1 Characteristics and practices of group discussion
5.2 Job application
5.3 Resume preparation
5.4 Writing reports – minutes of a meeting, accident, survey
5.5 E-mail – etiquette

Suggested Readings:

(i) *Practical English Usage.* Michael Swan. OUP. 1995.
(ii) *Remedial English Grammar.* F.T. Wood. Macmillan.2007
(iii)*On Writing Well.* William Zinsser. Harper Resource Book. 2001
(iv) *Study Writing.* Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
(v) *Communication Skills*. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
(vi) *Exercises in Spoken English.* Parts. I-III. CIEFL, Hyderabad. Oxford University Press
(Vii) Raman, Meenakshi and Shama, Sangeetha – Technical Communication Principles and Practice, Oxford University Press, New Delhi,2014.

Course Outcomes
The student will acquire basic proficiency in English including reading and listening

Comprehension, writing and speaking skills. .

- To help students develop listening skills for academic and professional purposes.
- To help students acquire the ability to speak effectively in English in real-life situations.
- To inculcate reading habit and to develop effective reading skills.
- To familiarize students with different rhetorical functions of scientific English.
- To enable students write letters and reports effectively in formal and business situations

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1						✓	✓	✓				✓
CO2						✓	✓	✓				✓
CO3						✓	✓	✓	✓			✓
CO4						✓	✓		✓			✓
CO5						✓			✓			✓

Course Code	**ETBS202**			
Category	**Basic Science Course**			
Course title	**Chemistry**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	3	**1**	**0**	**4**

Unit – I : Water Chemistry and Surface Chemistry

Hardness of water – Softening of hard water by ion exchange method – Boiler feed water – boiler troubles – Internal treatment methods – Estimation of hardness by EDTA method – Desalination of brackish water – Reverse Osmosis. Disinfection of water – Break point chlorination – Adsorption – Types of Adsorption – Freundlich and Langmuir adsorption isotherms – Applications of adsorption.

Unit – II : Electrochemistry and Corrosion

Electrode potential – Electrochemical cell – Measurement of EMF – Nernst equation for cell EMF – Concentration cells – Electrochemical series – Conductometry – Conductance, Cell constant – Types of conductometric titrations. Potentiometry – Principle of acid base titration. Corrosion – Dry and wet corrosion – Galvanic, concentration cell and pitting corrosion – Control of corrosion by Cathodic protection method.

Unit – III : Fuels and Storage Devices

Fuels – Classification – Calorific values – HCV and LCV – Analysis of coal – Proximate and ultimate analysis – Refining of petroleum. Cracking – Fixed bed – Synthetic petrol – Fischer – Tropsch process – Flue gas analysis by Orsat apparatus. Batteries – Primary and secondary – Dry cell – Lead acid storage battery –Ni-Cd battery – Lithium battery – H_2-O_2 fuel cell.

Unit – IV : Polymers and Nano Materials

Polymers – Types of polymerization – Addition, condensation and copolymerisation – Mechanism of addition polymerization (Free radical). Plastics – Thermoplastics and thermosetting plastics – Preparation, properties and uses of polyethylene, polyvinyl chloride, polystyrene, Nylon and bakelite. Nanochemistry – introduction to nano materials. Synthesis – Precipitation, sol-gel process, electrodeposition and chemical vapour deposition methods. Carbon nano tubes, fullerenes, nano wires and nano rods.

Unit – V : Engineering Materials and Spectroscopic Techniques

Refractories – Classification, characteristics (Refractoriness, RUL, Thermal spalling, porocity) and uses, Lubricants – Classification, properties (cloud and pour point, flash and fire point, viscosity index) and applications. Principles of spectroscopy – Beer – Lambert's Law – UV – Visible and IR spectroscopy – Basic principles and instrumentation (block diagram) – Fluorescence and its applications in medicine.

Suggested Tex Books

1. Jain, P.C. and Monica Jain (2010) "Engineering Chemistry" Dhanpat Rai & Sons, New Delhi

2. Dara, S.S. and Umare, S.S. (2014) “Text Book of Engineering Chemistry” S. Chand & Co. Ltd., New Delhi.

3. Gopalan, R., Venkappaya, D. and Nagarajan, S. (2008) “Engineering Chemistry” Tata Mc Graw Publications Ltd., New Delhi.

4. Puri, B.R., Sharma, L.R. and Pathania, M.S. (2013) “Principles of Physical Chemistry” Vishal Publication Company, New Delhi.

5. Sharma, Y.R. (2010) “Elementary Organic Spectroscopy, Principle and Chemical Applications” S. Chand Publishers, New Delhi.

6. Asim K Das and Mahua Das (2017) “An Introduction to Nanomaterials and Nanoscience” CBS Publishers & Distributors Pvt. Ltd., New Delhi.

Course Outcomes

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

- develop innovative methods to produce soft water for industrial uses, drinking purpose and understand concept of surface chemistry,
- study the concept of electrochemistry and its applications and corrosion control methods,
- understand the properties of fuels and applications of energy storage devices,
- synthesis and uses of various polymers and gain knowledge on refractories and lubricants,
- understand the concepts of certain analytical techniques and applications of nanochemistry.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓					✓			
CO2				✓	✓							
CO3	✓		✓									
CO4	✓				✓							
CO5		✓	✓	✓					✓			

Course code	ETES203				
Category	Engineering Science Course				
Course title	Programming for Problem Solving				
Scheme and Credits	L	T	P	Credits	
	3	0	0	3	

Unit 1: Introduction to Programming, Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. **(8 lectures)**

Unit 2: Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops. **(14 lectures)**

Unit 3: *Arrays: Arrays (1-D, 2-D), Character arrays and Strings, Basic Algorithms: Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required).* ***(12 lectures)***

Unit 4: Function: Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference, Recursion: Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort. (10 lectures)

Unit 5:

Structure: Structures, Defining structures and Array of Structures, Pointers: Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion oflinked list (no implementation). File handling (only if time is available, otherwise should be done as part of the lab). **(6 lectures)**

Suggested Text Books

(i) Byron Gottfried, Schaum's Outline of Programming with C,McGraw-Hill

(ii) E. Balaguruswamy, Programming in ANSI C, TataMcGraw-Hill

Suggested Reference Books

(i) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

Course Outcomes

The student will learn

- To formulate simple algorithms for arithmetic and logical problems.
- To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.

- To decompose a problem into functions and synthesize a complete Program using divide and conquer approach.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		✓		✓						✓		
CO2	✓	✓	✓		✓		✓	✓			✓	✓
CO3									✓			
CO4	✓				✓	✓	✓	✓				
CO5	✓		✓	✓		✓			✓		✓	✓

Course code	**ETBS204**			
Category	Basic Science Course			
Course title	**Mathematics - II**			
Scheme and Credits	**L**	**T**	**P**	**Credits**
	3	**1**	**0**	**4**

Module 1: Multivariable Calculus (Integration): (8 lectures)

Double integrals (Cartesian) - change of order of integration in double integrals - Change of variables (Cartesian to polar) - Applications: Area as a double integral.

Triple integrals (Cartesian) - Applications: Volume as a triple integral.

Module 2:Vector Calculus (Integration): (8 lectures)

Line, Surface and Volume integrals - Gauss divergence theorem (without proof) - Green's theorem in the plane (without proof) – Stokes theorem (without proof). Verification of the above theorems and evaluation of integrals using them.

Module 3: Ordinary differential equations: (8 lectures)

First order ordinary differential equations (Linear and Bernoulli's differential equations, exact differential equations). Solution of Second order ordinary linear differential equations with constant co-efficient (method of variation of parameters only). Solution of Second order ordinary linear differential equations with variable co-efficient (Euler and Legendre's linear equations).

Module 4: Complex Variable (Differentiation): (8 lectures)

Analytic functions and their properties-Cauchy-Riemann equations-harmonic functions - harmonic conjugate of elementary analytic functions– Construction of an analytic function. Mobius transformations.

Module 5: Complex Variable (Integration): (8 lectures)

Cauchy theorem (without proof) - Cauchy Integral formula (without proof) - Cauchy Integral formula for higher derivatives (without proof) – zeros and poles of an analytic functions

– singularities. Residues - Cauchy Residue theorem (without proof) - Evaluation of definite integral using them. Taylor's series and Laurent's series.

Suggested Text/Reference Books

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

3. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems,
9th Edn., Wiley India, 2009.

4. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.

5. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.

6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint,

7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Outcomes

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

The students will learn:

- The mathematical tools needed in evaluating multiple integrals and their usage.
- The effective mathematical tools for the solutions of differential equations that model physical processes.
- The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.
- To deal with Complex Variable for Differentiation that are essential in most branches of engineering.
- To deal with Complex Variable for Integration that are essential in most branches of engineering..

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓							✓		✓	✓
CO2	✓	✓	✓		✓							
CO3	✓	✓	✓	✓					✓		✓	✓
CO4	✓	✓		✓								
CO5	✓	✓	✓						✓			

Course code	ETHP205				
Category	Humanities and Social Sciences including Management courses				
Course title	Communication Skills and Language Laboratory				
Scheme and Credits	L	T	P	Credits	
	0	0	2	1	

List of Topics

1. Listening Comprehension
2. Pronunciation, Intonation, Stress and Rhythm
3. Common Everyday Situations: Conversations and Dialogues
4. Communication at Workplace
5. Interviews
6. Formal Presentations

Suggested Software package: Globarena Package for communicative English

The Globarena Package consists of the following exercises

1. Reading comprehension
2. Listening comprehension
3. Vocabulary exercises
4. Phonetics
5. Role Play in dialogues
6. Auto Speak

Suggested Readings:

i. English Pronouncing Dictionary Daniel Jones Current Edition with CD.
i. Spoken English- R. K. Bansal and J. B. Harrison, Orient Longman 2006 Edn.
ii. A Practical course in English Pronunciation, (with two Audio cassettes) by J. Sethi, KamleshSadanand& D.V. Jindal, Prentice-Hall of India Pvt. Ltd., New Delhi.
iii. A text book of English Phonetics for Indian Students by T.Balasubramanian (Macmillan)
iv. English Skills for Technical Students, WBSCTE with British Council, OL.

Course Outcomes:

- Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap At the end of the course learners will be able to:
- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialization successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1						✓	✓	✓		✓		
CO2						✓	✓	✓		✓		
CO3						✓	✓	✓		✓		
CO4						✓	✓	✓		✓		
CO5						✓	✓	✓		✓		
CO6						✓	✓	✓		✓		

Course code	**ETBP206**				
Category	Basic Science Course				
Course title	**Chemistry Laboratory**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	0	**0**	**3**	**1.5**	

Objectives:

- To list the water quality standards
- To assess the composition of an alloy
- To appreciate the practical significance of acidimetry, alkalimetry, permananganometry, conductometry and potentiometry
- To analyse quantitatively the amount of a substance present in a given sample.

List of Experiments:

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Ion exchange column for removal of hardness of water
4. Determination of chloride content of water
5. Determination of the rate constant of a reaction
6. Determination of cell constant and conductance of solutions
7. Potentiometry - determination of redox potentials and emfs
8. Saponification/acid value of an oil
9. Determination of the partition coefficient of a substance between two immiscible liquids
10. Adsorption of acetic acid by charcoal
11. Volumetric analysis

Course outcomes:

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

- Gain knowledge in the quantitative chemical analysis of water quality related parameters.
- Assess the composition of an alloy
- Analyse the quantitatively the amount of substance present in a given sample by acid-base, permanganometry .
- Analyse quantitatively the amount of substance present in a given sample by conductometry and potentiometry
- Analyse the quantitatively the amount of substance present in a given sample by acid-base and iodometry titration

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1				✓								
CO2	✓											
CO3			✓									
CO4	✓											
CO5	✓			✓								

Course code	**ETSP207**				
Category	Engineering Science Course				
Course title	**Computer Programming Laboratory**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	0	**0**	**4**	**2**	

Objectives:

To make the students conversant with

- Water treatment techniques, disinfection methods and adsorption techniques
- Working principal of electrochemical cell and knowledge about corrosion and control of corrosion.
- Sources, refining of petroleum various types of fuels, and knowledge about primary and secondary cells.
- Types of polymers, polymerization products, Uses of polymers and introduction to nono materials.
- Engineering materials such as refractories, lubricants and principles of sepectroscopy – UV and IR

[The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given]

Tutorial 1: Problem solving using computers:

Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Tutorial 12: File handling:
Lab 12: File operations

Laboratory Outcomes

- To formulate the algorithms for simple problems
- To translate given algorithms to a working and correct program
- To be able to correct syntax errors as reported by the compilers
- To be able to identify and correct logical errors encountered at runtime
- To be able to write iterative as well as recursive programs

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓					✓			
CO2				✓	✓							
CO3	✓		✓									
CO4	✓				✓							
CO5		✓	✓	✓					✓			

Course code	**ETSP208**				
Category	Engineering Science Courses				
Course title	**Engineering Graphics and Drafting**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	1	**0**	**4**	**3**	

Traditional Engineering Graphics:
Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Reading a Drawing; Sectional Views; Dimensioning, True Length, Angle.

Computer Graphics:
Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM)

(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

COURSE OBJECTIVES:

- To develop the ability to produce simple engineering drawing and sketches based on current practice
- To develop the means for communication of ideas, thoughts and design of objects, related to engineering applications, to others though drawing
- To develop the skills to read manufacturing and construction drawings used in industry
- To develop a working knowledge of the layout of plant and equipment

- To develop skills in abstracting information from calculation sheets and schematic diagrams to produce working drawings for manufacturers, installers and fabricators

Unit 1: Introduction to Engineering Drawing,
Introduction to Engineering Drawing: Lettering, Dimensioning and use of drawing instruments. Conic sections: Eccentricity method of/for drawing ellipse, parabola and hyperbola- Tangent and Normal from a point on the curve.

Unit 2: Orthographic Projections,
Orthographic projections: Introduction – Projections of points
Projections of Straight lines: Determination of true length and true angle of inclinations using half cone and trapezoidal methods – drawing the projections of straight lines using half cone method from true length and true angle of inclinations.

Unit 3: Projections of Regular Solids,
Projections of solids in simple position: Projections of cube, Tetrahedron, prisms, pyramids, cone and cylinder.
Projections of solids: Auxiliary projections – projections of prisms, pyramids, cylinder and cone when the axis is inclined to only one plane.

Unit 4:Sections and Sectional Views of Right Angular Solids,
Sections of solids: Sections of prisms, pyramids, cylinder and cones – true shape of section.
Developments of solids: Developments of lateral surfaces of solids using parallel and radial line methods.

Unit 5: Isometric Projections,
Isometric projections: Projections of simple solids.
Conversion of pictorial view of simple objects into orthographic projections (only elevation and plan)

Overview of Computer Graphics covering,
Introduction to CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars). The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.

Customisation & CAD Drawing

consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines and other basic geometric entities.

Annotations, layering & other functions

applying dimensions to objects and annotations to drawings; Setting up and use of Layers, Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation;

Suggested Text/Reference Books:

(i) Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House

(ii) Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education

(iii) Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication

(iv) Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

(v) (Corresponding set of) CAD Software Theory and User Manuals

Course Outcomes

All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students are prepared for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software. This course is designed to prepare the students:

- Communicate effectively through drawing
- Apply techniques, skills, and modern engineering tools necessary for engineering practice
- Exposure to the visual aspects of engineering graphics
- Exposure to engineering graphics standards
- Exposure to engineering communication

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1						✓	✓				✓	✓

CO2	✓	✓			✓			✓				
CO3	✓				✓		✓		✓			✓
CO4	✓	✓		✓			✓					
CO5	✓				✓							✓

S E M E S T E R - III

ETBS301	ENGINEERING MATHEMATICS - III	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

- The students will be trained on the basics of chosen topics of mathematics, namely, partial differential equations, Fourier series, Boundary value problems, Fourier transform and Z-transform.
- The above topics introduced in this course will serve as basic tools for specialized studies in engineering.

UNIT I

Formation of partial differential equations by eliminating arbitrary constants and arbitrary functions - Solution of standard type of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second order with constant coefficients.

UNIT II

Dirichle's conditions - General Fourier series - Odd and Even functions - Half range sine series - Half range cosine series - Complex form of Fourier series – Parseval's identity.

UNIT III

Solutions of one dimensional wave equation – One dimensional heat equation (without derivation) – Fourier series solutions in Cartesian co-ordinates.

UNIT IV

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem - Parseval's identity

UNIT V

Z-transform – Elementary properties – Inverse Z-transform - Convolution theorem – Solution of difference equations using Z-transform.

TEXT BOOKS

1. Kandasamy, P., Tilagavathy, K., and Gunavathy, K., "Engineering Mathematics", 6th Edition, (Vol. I & II), S. Chand & Co Ltd., New Delhi, 2006.
2. Ventakataraman, M.K., "Engineering Mathematics", The National Publishing Co., Chennai, 2003.

REFERENCES

1. Veerarajan, T., "Engineering Mathematics", 3rd edition, Tata McGraw Hill Pub, 2005.
2. Singaravelu, A., "Engineering Mathematics", Meenakshi Publications, Chennai, 2004.

COURSE OUTCOMES

1. Students would acquire basic understanding of the most common partial differential equations and to learn some methods of solving them
2. Students would acquire basic understanding of the Fourier series, Fourier transform and Z-transform and to learn some methods of solving them.

3. The students should be able to solve some boundary value problems.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓			✓							
CO2	✓	✓			✓						✓	
CO3	✓	✓			✓							✓

ETES302	**ENVIRONMENTAL STUDIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I

Introduction - Multidisciplinary nature of environmental studies - Definition, scope and importance - Need for public awareness.

Natural resources - Forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.- Role of an individual in conservation of natural resources.- Equitable use of resources for sustainable lifestyles.

UNIT II

Concept of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological - pyramids - Introduction, types, characteristic features, structure and function of the following ecosystem - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT III

Introduction – Definition: genetic, species and ecosystem diversity - Bio geographical classification of India - Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values - Biodiversity at global, National and local levels - India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts - Endangered and endemic species of India - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT IV

Definition - Cause, effects and control measures of Air pollution - Water pollution - Soil pollution - Marine pollution- Noise pollution - Thermal pollution - Nuclear hazards - Solid waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Disaster management: floods, earthquake, cyclone and landslides. Sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, and watershed management - Resettlement and rehabilitation of people; its problems and concerns. - Environmental ethics:

Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Wasteland reclamation - Consumerism and waste products - Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation.

UNIT V

Population growth, variation among nations - Population explosion – Family Welfare Programme - Environment and human health - Human Rights - Value Education - HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health -Case Studies.

Field work:

Visit to a local area to document environmental assets river / forest / grassland / hill / mountain - Visit to a local polluted site - Urban / Rural / Industrial /Agricultural - Study of common plants, insects, birds - Study of simple ecosystems-pond, river, hill slopes, etc. **(Field work Equal to 5 lecture hours)**

TEXT BOOKS

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)

REFERENCES

1. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
2. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
3. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
4. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
5. Down to Earth, Centre for Science and Environment (R)
6. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
7. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
8. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
9. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
10. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
11. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
12. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
13. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
14. Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
15. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
16. Survey of the Environment, The Hindu (M)
17. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)

18. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R)
19. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)

ETES303	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamentals of forces and their effects with their governing laws.
- To understand the definitions of particle, body forces and their equilibrium conditions.
- To understand and predict the forces and its related motions.

UNIT I

Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminancy

UNIT II

Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines

Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

UNIT III

Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack

Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

UNIT IV

Review of particle dynamics- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained

motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy.Impulse-momentum (linear, angular); Impact (Direct and oblique).

UNIT V

Introduction to Kinetics of Rigid Bodies covering, Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation

Mechanical Vibrations covering, Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums;

TEXT BOOKS

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.

REFERENCES

1. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
2. Shanes and Rao, Engineering Mechanics, (2006)Pearson Education,
3. Hibler and Gupta,Engineering Mechanics (Statics, Dynamics) (2010)by Pearson Education
4. Reddy Vijaykumar K. and K. Suresh Kumar, Singer's Engineering Mechanics, (2010)
5. Bansal R.K., A Text Book of Engineering Mechanics, .(2010), Laxmi Publications
6. Khurmi R.S., Engineering Mechanics, (2010), S. Chand & Co.
7. Tayal A.K., Engineering Mechanics, (2010), Umesh Publications

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Use scalar and vector analytical techniques for analysing forces in statically determinate structures
2. Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems
3. Apply basic knowledge of maths and physics to solve real-world problems
4. Understand measurement error, and propagation of error in processed data
5. Understand basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts);
6. Understand basic dynamics concepts – force, momentum, work and energy;
7. Understand and be able to apply Newton's laws of motion;

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓									✓		✓
CO2	✓	✓					✓					
CO3	✓	✓										
CO4			✓		✓					✓		
CO5	✓		✓									
CO6			✓				✓					✓
CO7	✓		✓									

MMES304	**THERMAL ENGINEERING**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

COURSE OBJECTIVES

- To give an idea regarding the basic concepts and laws of thermodynamics
- To introduce the fundamentals of thermal engineering such as internal combustion engines and steam turbines
- To introduce the fundamentals of air compressors, refrigeration and air conditioning
- To introduce the basic concepts of steam turbines
- To introduce the fundamentals of various modes of air heat transfer.

UNIT I

Thermodynamics - Definition - heat and work - open system and closed system - state, property and change of state of a system - properties of vapor - internal energy - entropy, dryness fraction - Calorimeter for determination of dryness fraction.

UNIT II

Cycles of operation - Otto, Diesel and Semi-diesel - calculation of air standard efficiency and relative efficiency - Indicator diagram - Power and Mechanical efficiency - performance curves - heat balance - problems.

UNIT III

Reciprocating air compressor - single and multistage compression - inter cooling - calculation of main dimensions - Effect of clearance volume - Volumetric efficiency.

UNIT IV

Rankine cycle with reheating and regenerating, feed heating, steam turbines - details - compounding of turbine - velocity diagram - blade efficiency - reaction turbine - height of blade and diameter of drum.

UNIT V

Primary modes of heat transfer - basic laws of conduction, convection and radiation - simple problems - refrigeration and air-conditioning - General principles of refrigeration - C.O.P calculations of psychometric chart - air conditioning methods.

TEXT BOOKS

1. Khurmi R.S., Thermal Engineering, S.Chand & Co., New Delhi.

2. Ballaney P.L., Thermal Engineering, Khanna Pub., New Delhi. 1997.

REFERENCES

1. Gupta C.P and Rajendra Prasad, Engineering Thermodynamics.
2. Spalding and Cole, Engineering Thermodynamics, ELBS.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the laws of thermodynamics
2. Know the different types combustion engines.
3. Differentiate Otto and diesel cycles
4. Obtain knowledge about air compressors, refrigeration and air conditioning, and modes of air heat transfer.
5. Obtain knowledge of steam turbines

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓						✓		
CO2		✓										
CO3			✓		✓						✓	
CO4		✓				✓			✓			
CO5		✓	✓	✓	✓	✓		✓				✓

MMPC305	**MACHINE TOOL TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the different types and functions of metal cutting machine tools.
- To provide in depth knowledge about various machine tools and operating procedures.
- To illustrate different mechanisms used in metal cutting machines.
- To understand the basic concepts of computer numerical control (CNC) machine tool and CNC programming.

UNIT I

Lathe: Specifications of centre lathe - operations performed - accessories and attachments - principle of capstan and turret lathes - layout of tools.

Shaper, Planner and slotter: General arrangement - principle of operation - drive mechanisms.

UNIT II

Milling machine: Types - specification - operations - types of cutters - attachments and accessories - examples of work.

Drilling and Boring: Types - specification of drilling machines - operations - accessories and attachments - types of boring machines - jig boring.

Sawing: Power saws - types and principle of operation.

UNIT III

Purpose – classification – surface finish – applications – grinding wheel – types – specifications – selection – surface grinding machine – block diagram – functions of each part – cylindrical grinding – Centreless grinding – Comparison – infeed, end feed and through feed. Balancing, dressing, loading and Truing of wheel

UNIT IV

Overview of NC, CNC and DNC –CNC System – Constructional features of CNC machines - Machining center – Turning center – Turn mill center. Drives – Transmission belting – axial feed drives – slideways – feedback devices. Work and Tool holding devices.

UNIT V

Manual part programming – sample programs:Turning, milling, drilling and face milling –Computer aided part programming – languages – geometric statements - point to point program – programming the tool path – mission commands – Simple examples of APT programming.

TEXT BOOKS

1. Suresh Dalela, "Manufacturing Science & Technology", Vol. I & II, Umesh Publications, 1997.
2. Radhakrishnan, P., "Computer Numerical control of Machine Tools", New central Book Agency, 2002.

REFERENCES

1. Jain, R.K., "Production Technology", Khanna Publications, New Delhi, 1995.
2. Hajra Choudhry, S.K., "Elements of Workshop Technology", Media Promoters & Publications Pvt. Ltd, 1994.
3. HMT Hand Book, "Production Technology", Tata McGraw-Hill Publication Co. Ltd, 1996.
4. Kalpakjian, S., "Manufacturing Engineering & Technology", 3rd Edition, Addition Wesley Inc. 1997.
5. Kumar, B., "Manufacturing Technology", Khanna Publishers, New Delhi, 2000.
6. Jonathan Lin. S.C., "Computer Numerical Control from Programming to Networking", Delmar Publishers, 3rd Edition 2009.
7. Krar, S.F., and Check, A.F., "Technology of Machine Tools", Tata McGraw-Hill, New Delhi, 1998.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Know the different types of operations with necessary tools.
2. Understand the mechanisms and their settings involved in appropriate machine tool.
3. Differentiate single point and multi point cutting tools and machines.
4. Obtain knowledge about advanced machine tools.
5. Gain and apply the knowledge of CNC machines and programming

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓										✓
CO2	✓	✓	✓	✓	✓					✓		
CO3		✓	✓		✓						✓	
CO4		✓		✓	✓							
CO5	✓	✓	✓	✓							✓	

MMPC306	**ENGINEERING METROLOGY**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

COURSE OBJECTIVES

- To understand the basic principles of measurements
- To introduce the various methods of measuring mechanical parameters
- To learn about advancements in measurement and automation

UNIT I

General concept - Generalised measurement system - Units and standards - Measuring instruments: sensitivity, stability, range, accuracy and precision - static and dynamic response - repeatability - systematic and random errors - correction, calibration - Introduction to Dimensional and Geometric Tolerancing - interchangeability.

UNIT II

Definition of metrology - Linear measuring instruments: Vernier, micrometer, Slip gauges and classification,-Tool Maker's Microscope-interferometer, optical flats,- Comparators: limit gauges Mechanical, pneumatic, electrical and differential comparators - applications. Angular measurements: Sine bar, Sine center, bevel protractor, Auto Collimators and Angle Decker.

UNIT III

Measurement of screw threads: Thread gauges, floating carriage micrometer- Measurement of gear tooth thickness: constant chord and base tangent method - Gleason gear testing machine - Radius measurements - surface finish: equipments and parameters, straightness, flatness and roundness measurements.

UNIT IV

Measurement of force, torque, power: - mechanical, pneumatic, hydraulic, electrical types and Strain gauges - Pressure measurement – Flow measurement: Venturi, orifice, rotameter, pitot tube – Temperature measurement: bimetallic strip, thermocouples, pyrometer, electrical resistance thermistor and Alignment tests for machine tools.

UNIT V

Precision instruments based on laser - Principles-laser interferometer - application in measurements and machine tool metrology - Coordinate Measuring Machine (CMM): Need, construction, types, applications. In process control with computer aided inspection - Machine vision system - fundamentals and applications.

TEXT BOOKS

1. Jain, R.K., "Engineering Metrology", Khanna Publishers, 2005.
2. Alan, S., Morris, "The Essence of Measurement", Prentice Hall of India, 1997.

REFERENCES

1. Gupta, S.C., "Engineering Metrology", Dhanpatrai Publications, 2005.
2. Jayal, A.K., "Instrumentation and Mechanical Measurements", Galgotia Publications, 2000.
3. Beckwith, Marangoni, and Lienhard, "Mechanical Measurements", Pearson Education, 2006.
4. Donald Deckman, "Industrial Instrumentation", Wiley Eastern, 1985.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the basics of measurements and know various linear, angular, form measuring equipments- their principle of operation and applications.
2. Select appropriate measuring instrument for a required mechanical parameter to a specific application.
3. Know about modern measuring equipments for a production industry.
4. To gain knowledge on alignment of machine tools
5. To understand the basics of advance inspection stystems

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓											✓
CO2	✓			✓	✓					✓		
CO3		✓										✓
CO4	✓	✓	✓		✓		✓	✓			✓	✓
CO5	✓	✓	✓		✓		✓	✓			✓	✓

MMSP307	**THERMODYNAMICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To inculcate the knowledge about the working of I.C engines and different types of dynamometers.
- To study the valve timing and port timing of an IC engine
- To make the students understand the working principle of various flow and pressure measuring devices.

LIST OF EXPERIMENTS

1. Study and valve timing on four stroke diesel engine.
2. Study and port-timing on two stroke petrol engine.
3. Dismantling and assembling of four stroke diesel engine.
4. Study of Carburettor
5. Study of fuel injection pump
6. Study of cooling system

7. Study of lubrication system
8. Study of air compressor
9. Measurement of temperature using resistance temperature detector
10. Determination of coefficient of discharge of orifice /Venturimeter
11. Measurement of displacement using LVDT
12. Experiments on DC Servo motor controller
13. Experiment on DC motor position control system

COURSE OUTCOMES

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

1. Understand the various types of engines and working principles of dynamometers.
2. Know the dismantling and assembling procedure of a four stroke CI engines.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓							✓	
CO2		✓								✓		

MMCP308	**MACHINE TOOL LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To provide hands-on experience on the use of metal working machines such as lathe shaper and slotter.
- To study the constructional features of automatic and turret lathe
- To study the constructional features of cylindrical and surface grinding machines.
- To provide hands-on experience in wood Turning of simple models.

LIST OF EXPERIMENTS:

1. Plain Turing
2. Step Turing
3. Taper Turing
4. Thread Cutting (Internal & External)
5. Knurling
6. Key way machining on a slotter
7. Convex profile machining on a slotter
8. T-slot milling
9. Keyway machining using a shaper
10. External dovetail machining on a shaper
11. Internal dovetail machining on a shaper
12. Study of Single-spindle automatic lathe
13. Study of capstan lathe and turret lathe
14. Study of gear hobbing machine
15. Study of cylindrical grinding machine
16. Study of surface grinding machine

COURSE OUTCOMES

Upon the completion of this course, students would be able to

1. Handle metal working machines such as lathe and shaper milling and slotter
2. Carry out simple operations on lathe and shaper milling and slotter
3. Understand the constructional features of automatic and turret lathe
4. Understand the constructional features of cylindrical and surface grinding machines

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓	✓						✓		
CO2	✓		✓									
CO3	✓		✓							✓		✓
CO4	✓		✓									

MMCP309	**METROLOGY LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To educate the students on the handling and use of precision measuring instruments used during the manufacturing processes.

LIST OF EXPERIMENTS:

1. Checking the straightness of straight edge
2. Calibration of a dial gauge
3. Measurement of internal diameter (4 balls)
4. Calibration of micrometer
5. Measurement of internal taper
6. Measurement of external taper (Sine Bar and Roller)
7. Calibration of plain plug gauge
8. Measurement of external radius and internal radius
9. Inspection of screw thread
10. Gear inspection
11. Checking the flatness of surface plate
12. Process capability

COURSE OUTCOMES

Upon the completion of this course, students would be able to

1. Understand the usage of many precision instruments and their respective handling methods.
2. Learn to calibrate the precision instruments.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓	✓					✓		
CO2	✓			✓	✓						✓	

EEBS401	PROBABILITY, RANDOM PROCESSES AND NUMERICAL METHODS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the probability, random processes, and statistical methods designed to contribute to the process of making scientific judgments in the face of uncertainty and variation.
- To develop the skills of the students in numerical mathematics - using method of finite difference interpolation,
- Finding numerical solution of algebraic and transcendental equations.
- Finding numerical solution of ordinary and partial differential equations.

UNIT I

Definition – Types of random variables - probability distribution function - probability density function – expectation and moments – moment generating functions – joint probability distribution -marginal probability distribution function – joint probability density function – marginal probability density function – conditional probability density function.

UNIT II

Classification of random processes – methods of description of a random process – special classes of random processes – Average values of random process - stationarity – Autocorrelation function and its properties - cross correlation function and its properties.

UNIT III

Hypothesis, testing – Large sampling tests – small sampling test based on t, F and chi-square distributions – interval estimates of mean, standard deviation and proportion.

UNIT IV

Interpolation: Gregory Newton forward and backward interpolation formula; Stirling's central difference formula; Lagrange's interpolation formula for unequal interval.
Numerical differentiation: Using Newton's forward and backward interpolation formula.
Numerical integration: Trapezoidal rule, Simpson's one-third and three-eight rules.

UNIT V

Solution of algebraic and transcendental equations: Bolzano's bisection method, Regula-falsi method, Newton–Raphson method.
Solution of simultaneous algebraic equation: Gauss elimination method, Crout's method, Gauss – Seidel iteration method.
Solution of ordinary differential equations: Taylor series method, Runge–Kutta fourth order method, Milne's - Predictor corrector method.

TEXT BOOKS

1. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., "Probability and random processes", S. Chand & Co. Ltd.
2. Veerarajan, T., "Probability theory and Random Process", Tata McGraw-Hill Co. Ltd, New Delhi, 2005.

REFERENCES

1. Lipschutz, S., and Schiller, J., "Schaum's outlines – Introduction to probability and statistics", McGraw-Hill, New Delhi, 1998.
2. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., "Numerical Methods", S. Chand & Co. Ltd., New Delhi, 2004.
3. Venkataraman, M.K., "Numerical method in science and Engineering", National Publishing Co., Chennai, 2003.

COURSE OUTCOMES

At the end of the course, the students would.

1. Understand the concept of algebraic and transcendental equations
2. Acquire skills in handling situations involving random variables, random processes
3. Solve problems for engineers in using numerical methods.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓							✓	
CO2	✓	✓		✓						✓		
CO3	✓	✓		✓	✓							✓

MMES402	**MATERIAL SCIENCE**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

COURSE OBJECTIVES

To impart fundamental knowledge on the structure of Engineering Materials,

- To impart knowledge about characteristics of polymer, ceramic and metal matrix composite materials.
- To impart knowledge about magnetic characteristics of engineering materials

UNIT I

Unit cell, Crystal systems, BCC, FCC & HCP structures, Crystallographic planes & direction, Miller indices, Crystal imperfections - point, line & area defects. Constitution of alloys, compounds & solid solutions, Gibbs phase rule, lever rule.

UNIT II

Introduction – Processing of plastic materials – Thermo plastics – Thermosetting plastics – Elastomers – applications - Materials selection for engineering designs using plastic materials.

UNIT III

Introduction – Traditional and engineering ceramics – Electrical properties of ceramics – Mechanical properties of ceramics – Thermal properties of ceramics – Glasses – applications.

UNIT IV

Introduction – Fiber reinforced plastic composite materials - Fibers and matrix materials – Concrete – Asphalt and asphalt mixes – Wood – Sandwich structures – Metal matrix and ceramic matrix composites-applications. Natural Fiber and Natural Polymer based Composite materials - Introduction

UNIT V

Types of magnetism – Magnetization and Demagnetization of ferromagnetic metal – Soft magnetic materials – Hard magnetic material – Ferrites – applications. Semiconductor materials – Conductor and resistor materials – Super conducting materials – Di-electric materials – applications.

TEXT BOOKS

1. William F. Smith., "Principles of Materials Science and Engineering", Third Edition, McGraw-Hill, Inc., 1996.

REFERENCES

1. Kenneth. G. Budinski, Michael K. Budinski, "Engineering Materials Properties and Solution", 6th Edition, Prentice Hall International, 1999.
2. Higgins, R.A., "Properties of Engineering Materials", Viva low priced student edition, 2nd Edition, 1998.
3. Raghavan, V., "Materials Science and Engineering", Prentice Hall of India, 1991.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the basic structures of Engineering materials
2. Impart fundamental knowledge about Polymer composites;
3. Use Bio degradable materials for the future will keep the environment clean
4. Implement Fiber based composites results in high industrial productivity
5. Understand the properties of ferric and non-ferric materials

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓										✓	
CO2		✓										
CO3				✓				✓	✓			
CO4			✓									✓
CO5	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓

MMPC403	**KINEMATICS AND DYNAMICS OF MACHINERY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the different types of mechanism.
- To provide in depth knowledge about power loss in different types of bearings and clutches.
- To draw the turning moment diagram of reciprocating engines.
- To illustrate the different types of problem in balancing and vibration of rotating masses
- To introduce as a tool for static and dynamic analysis of mechanisms for use in design and engineering

UNIT I

Kinematics – links- pairs, chain – mechanisms and inversions – velocity and acceleration of single slider crank chain by relative velocity method. Klein's construction for velocity and acceleration of single slider crank chain.

UNIT II

Friction: frictional loss of power in journal, pivot and collar bearings. Clutches – single plate multiple plate and cone clutches. Belt and rope drives- ratio of tension- power transmitted.

UNIT III

Turning moment: De Alembert's principle-inertia force, calculation of turning moment in reciprocating engines. Co-efficient of fluctuation of energy, coefficient of fluctuation of speed - fly wheels for punch press.

UNIT IV

Balancing - static and dynamic balancing - Balancing of rotating masses, balancing of reciprocating masses – introduction to primary and secondary balancing.

UNIT V

Vibrations: Definitions for free Forced and damped oscillations of single degree freedom system with examples. Whirling of shafts. Torsional oscillations of two rotor systems

TEXT BOOKS

1. Ballaney, P.L., "Theory of machines", Khanna Publishers New Delhi
2. Khurmi, and Gupta, "Theory of machines", Chand & Co.

REFERENCES

1. Thomas Bevan, "Theory of machines", Longman.
2. Abdulla Sheriff, "Theory of machines", Danpat Rai & Co.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Know the different types of links and pairs in the kinematic chain.
2. Understand the power loss in friction for different types of clutches and bearings.
3. Obtain knowledge about the turning moment diagram for reciprocating engines.
4. Know the different types of balancing of static and dynamic system.
5. To understand the different types of vibration systems

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓									✓	
CO2	✓			✓								
CO3	✓		✓							✓		✓
CO4	✓				✓							
CO5	✓	✓	✓	✓	✓			✓				✓

MMPC404	METAL JOINING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Apply knowledge of materials to prescribe appropriate welding process for specific applications;
- Model and simulate welding processes to conduct experiments and analyze the performance using modern tools
- Understand the environmental issues related to each welding methods and try to develop 'green welding' methods.

UNIT I

Basics of arc welding processes - Classification of welding and allied Processes - Welding arc: physics involved in arc, structure and characteristics, arc efficiency calculation, methods of arc initiation and maintenance, arc stability, arc blow - V-I characteristics, constant current and constant voltage characteristics, duty cycle, simple problems Arc Welding Power Sources: welding transformers, generators, rectifiers, inverters; Classification of electrodes - Metal Transfer: forces affecting metals transfer - modes of metal transfer.

UNIT II

Arc welding processes-Basic principles, Process variables, Chief characteristics and applications of the following processes: Shielded(Manual) Metal Arc Welding (SMAW/MMAW) - Submerged Arc Welding (SAW), Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW), CO_2 welding, Flux cored Arc Welding (FCAW), Electro Slag and Electro Gas Welding - Atomic Hydrogen Welding.

UNIT III

Resistance welding processes Basic principle, Process variables, Welding Sequence, Process characteristics and applications of the following processes: Spot welding, simple problems - Seam welding - Projection welding - Percussion welding - Resistance Butt welding - Flash Butt welding - High Frequency Resistance Welding (HFRW) and High Frequency Induction Welding (HFIW)

UNIT IV

Solid state welding processes, Basic principles, Process parameters, Process characteristics and applications of the following Processes: Friction welding – Friction stir welding - Explosive welding - Ultrasonic welding - Diffusion Bonding. **Allied processes**: Basic principles, Process variables, Chief characteristics and applications of the following processes: Electron Beam Welding (EBW) - Laser Beam Welding (LBW) - Thermit welding - Gas welding - Soldering - Brazing - Adhesive Bonding - Welding of plastics.

UNIT V

Defects in welding in various processes - Causes and remedies; Ultrasonic dye penetrant, magnetic particle inspection. X ray testing procedures and identification of defects – case studies. Automation in welding – Seam tracking vision and arc sensing welding robots. Design of weldments-Welding symbols positions of welding joint and groove design. Weld stress –Calculations – Design of weld size.

TEXT BOOKS

1. Parmar, R.S., "Welding Processes and Technology", Khanna Publishers, New Delhi, 2007.
2. Prasad, J., and Nair, C.G.K., "Non-Destructive Test and Evaluation of Materials", Tata McGraw-Hill Publishers, New Delhi, 2011.

REFERENCES

1. Nadkarni, S.V., "Modern Arc Welding Technology", Oxford & IBH Publishing Co.Pvt.Ltd, NewDelhi, 1996.
2. Khanna, O.P., "Welding Technology" Dhanpat Rai & Sons Publishers, New Delhi, 1993.
3. O'Brien, R.L., **"**Welding Hand Book, Welding Process", Vol.II, 8th Edition, American Welding Society, 1991.
4. Little, R.L., "Welding and Welding Technology", Tata McGraw Hill Publishing Company Limited, New Delhi, 1990.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the physics behind welding arc and heat flow equations;
2. Distinguish between fusion welding processes and solid state welding processes;
3. Select appropriate welding process for joining specific materials;
4. Inspect welding defects using Non-destructive testing methods;
5. Understand the environmental issues and safety requirements for each processes.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓			✓							✓
CO2	✓	✓			✓					✓		
CO3	✓	✓			✓							
CO4			✓					✓				✓
CO5	✓				✓							

MMPC405	**METAL MACHINING PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To know the Metal Cutting Process.
- To know the basic concepts of temperature developed during machining.
- To understand Tool Materials, Tool Life and Tool Wear.

UNIT I

Tool Materials: HSS, Carbide and coated tools, CBN, Ceramic and PCD. Tool geometry - single point cutting tool and multi point cutting tool - Tool signature-Tool designation: ASM, DIN, British standards and their relationships.

UNIT II

Metal Cutting Process: Chip formation - Types of chips - chip breakers- Chip thickness ratio, radius of chip curvature, cutting speed, feed and depth of cut –Theories of formation of built-up edge and their effect - Chip formation in drilling and milling.

UNIT III

Introduction to Orthogonal and Oblique cutting processes- The force system- Velocity relationship- forces in turning and milling- Relationship between forces, speed, feed and depth of cut- - Forces and energy calculations (Merchant's Analysis) Single Point Cutting Tool: Various systems of specifications, single point cutting tool geometry and their inter-relation.

UNIT IV

Tool Life and Tool Wear: Theories of tool wear – adhesion, abrasive and diffusion wear mechanisms, forms of wear, Tool life criteria and machinability index. Effect of machining parameter on tool life- measurement techniques for tool wear- Tool economics-basic concepts- simple problem

UNIT V

Thermal Aspects of Machining and Cutting Fluid: Regions of heat generation; Heat In the Primary Shear Zone, Heat at the Tool/work Interface, Heat Flow at the Tool Clearance Face, Average shear plane temperature; Average chip-tool interface temperature; method of tool temperature measurement, temperature distribution in tool, Cutting Fluid: Types and composition of cutting fluids, selection of cutting fluid.

TEXT BOOKS

1. Boothryd, "Fundamentals of Machining", Edward Amold Publishers Ltd, 1975.
2. David Son, LacainGoud , "Tool Design" , Tata Me GrawHill.
3. Juneja. B. L and Sekhon.G.S, "Fundamentals of metal cutting and machine tools", New Age International(p) Ltd., 2003.

REFERENCES

1. Sehrawat, M.S., and Narang, J.S., "Metal Cutting Principles", Milton C Saw, Oxford.
2. MC Shaw, "Metal Cutting Principles", Oxford and IBH Publications, New Delhi, 1969.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Gain knowledge on various tool materials and tool signature
2. Analyze the Tool Life and Tool Wear.
3. Understand basic concept of tools and tool materials.
4. Distinguish between Orthogonal and Oblique cutting.
5. Understand the concepts of thermal aspects of machining.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓	✓			✓				✓
CO2	✓	✓							✓		✓	
CO3	✓	✓										
CO4			✓		✓						✓	
CO5		✓	✓	✓				✓				✓

MMPC406	**INDUSTRIAL MANAGEMENT & ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce students various Industrial Engineering and Management concepts.
- To provide an understanding of the systematic approaches of various management functions.
- To enhance the management skills through the application of appropriate techniques.

UNIT I

Engineering Economics - nature and scope of managerial economics – basic economic tools in managerial economics - decision and efficiency analysis. Consumer behaviour - law of demand and supply - elasticity - determinants - uses. Pricing under different market conditions: Monopoly - monopolistic competition - oligopoly, pricing policies - Porter's five forces - model of competition. Financial markets: Primary and secondary markets - money market instruments - capital. market instruments. National income - concepts. Trade and development: Free trade versus protection - balance of payments - globalisation - W.T.O.

UNIT II

Organizational Components to be Managed - Individual Behaviour: Governing factors -Determinants of personality . Motivation – Importance – Theories: Maslow’s Theory of Need Hierarchy - Theory X and Theory Y - techniques of motivation. Job satisfaction – Governing factors – Effects.Group Dynamics - Development of Inter- personal Relationship.Group Behaviour -Group cohesiveness.Conflict - Functional and Dysfunctional Conflict - Conflict resolution model.Stress – Sources – Management of Stress. Leadership – Types – Theories:Hersey and Blanchard’s situational leadership model - Path-Goal theory

UNIT III

Principles of Management - Functions of management - Scientific management: Contributions of Taylor, Gilberth, Gantt- Forms of business organisation - line, functional, line and staff organisations - Industrial ownership: single, partnership, joint stock company, co- operative organisations, state and central government owned. Costing: Objectives - Elements of costs - estimation of selling price – simple problems, Allocation of overheads.

UNIT IV

Break-even analysis - concept and applications - Depreciation - straight line and declining balance method.

Plant Location: Influencing factors. Location models – Breakeven analysis – Qualitative factor rating Method.

Plan Layout: Layout Objectivess – Types of Layout – Load distance analysis – Muthur grid technique. Concept of Line balance – Largest candidate rule.

UNIT V

Method Study: Objectivess and procedure for methods analysis, Recording techniques, Operations Process Chart, Flow Process Chart, Man-Machine chart , Multiple Activity Chart, and Two Handed process chart, String Diagram, Therbligs, Micro motion and macro-motion study: Principles of motion economy.

Work Measurement: Objectives, Work measurement techniques – time study, work sampling -Determination of time standards- Observed time, basic time, normal time, rating factors, allowances, and standard time.

TEXT BOOKS

1. Kumar. B., "Industrial Engineering", Khanna Publications, 1995.
2. M. Govindarajan and S.Natarajan, Principles of Management, Prentice Hall of India Pvt. Ltd. New Delhi, 2007.
3. Jain, S.K., "Applied Economics for Managers and Engineers", Vikas Publishers, 1997.

REFERENCES

1. Herald Koontz and Heinz Weihrich, "Essentials of Management", McGraw Hill Publishing Company, Singapore International Edition, 1980.
2. "Mechanical Estimating and Costing", TTTI Madras, Tata McGraw Hill,2003.
3. Mehta P.L., "Managerial Economics", Sultan Chand & Sons, 1995.
4. Vaish M.C., "Money, Banking, Trade and Public Finance", New Age International (P) Ltd., 1996.
5. Ties, AF, Stoner and R. Edward Freeman, "Management", Prentice Hall of India Pvt. Ltd. New Delhi, 1992.
6. Chandran, S., "Organizational Behaviors", Vikas Publishing House Pvt. Ltd, 1994.
7. Jain. S.K., Applied Economics for Managers and Engineers, Vikas Publishers, 1997.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Recognise the factors such as demand and production for pricing criteria
2. Understand and learn the effective interpersonal, team building and leadership skills
3. Improved the organizational performance through the effective management of human resources
4. Practice the process of management's four functions: planning, organizing, leading, and controlling
5. Differentiate between the various types of organizational structures and patterns

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓										✓	
CO2				✓						✓		
CO3		✓										
CO4				✓							✓	
CO5				✓								

MMCP407	**DYNAMICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To supplement the principles learnt in kinematics and Dynamics of Machinery.
- To make the students understand the working principle of various types of governors, balancing systems, Cam analyzer, Torsional vibration of single rotor system, whirling speed concept, action of forces in gyroscope.

LIST OF EXPERIMENTS

1. Experimental verification of natural frequency in undamped vibration of single rotor system.
2. Determine the characteristic curves of watt/ Hartnell governors.
3. Determination of mass moment of inertia of connecting rod and fly wheel.
4. Studies on cam analyser
5. Study of gyroscopic couple.
6. Whirling of speed – determination of critical speed.
7. Study and experiments on static and dynamic balancing of rotating masses.

COURSE OUTCOMES

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

1. Determine the mass moment of inertia of connecting rod and flywheel either experimentally of theoretically or both.
2. Understand the working principle of governors.
3. Calculate the stiffness of springs.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓											✓
CO2				✓						✓		
CO3		✓										

MMCP408	METAL JOINING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To inculcate the knowledge of making different types of joints in welding
- To study effect of welding power sources on heat input and bead geometry
- To provide on hand experience in the non-destructive testing of weldments

LIST OF EXPERIMENT

1. But Joint
2. Lab Joint
3. Corner Joint
4. 'T' Joint
5. Comparative evaluation of welding performance of Arc Welding power source.
6. Effect of heat input on bead geometry.
7. Effect of Electrode Polarity Arc Welding Performance
8. Influence of Multi-Pass Welding on Micro structure and hardness.
9. Temperature Measurement in Arc Welding Process
10. Comparative evaluation of cutting performance of different gas Flames.
11. Distortion Measurement
12. Magnetic particle test
13. Dye penetrant test

COURSE OUTCOMES

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

1. Fabricate different types of joints
2. To understand effect of heat input on bead geometry
3. To understand effect of power sources in arc welding

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓									✓		
CO2				✓								✓
CO3		✓									✓	

MMCP409	METAL MACHINING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To provide hands-on experience on spur and helical gear machining
- To provide hands-on experience on clutch milling and flute milling
- To carry out alignment test on lathe
- To learn to measure the forces in lathe and grinding

LIST OF EXPERIMENTS

1. Lathe tool dynamometer
2. Power measurement in a lathe
3. Estimation of cutting forces by Merchant's theory
4. Alignment test on lathe
5. Grinding tool dynamometer
6. Plain milling
7. Spur gear milling
8. Helical gear milling
9. Flute milling
10. Pantograph milling
11. Straight tooth clutch milling (3/4 dogs)

COURSE OUTCOMES

Upon the completion of this course, students would be able to

1. Understand the usage of dynamometers in lathe and grinding
2. To make spur, helical and to flute milling
3. To check the alignment of lathe structure

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓	✓							✓
CO2	✓				✓					✓		
CO3				✓	✓							✓

MMPC501	**CASTING TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To impart about the sand casting process and its importance.
- The basic phenomena involved in metal casting process, gating and risering system.
- To introduce Modern casting methods

UNIT I

Sand: Moulding Sands- Properties- Additives used, Control of Moulding Sands. Moulding -Types of Moulding- Moulding Processes, Instruments used for different methods. Moulding Materials- Quality moulds- Dressing of moulds. Moulding machine.

Pattern: Types of Pattern - Pattern Materials - Pattern Allowances- Pattern Making Machinery. Core: Purpose of Cores- Preparation of Cores- Core Materials and Additions- Core Dressing, Effect on Castings- Location and Fixing.

UNIT II

Melting: Melting Furnaces- Ferrous and Non-Ferrous Metals- Charging Operation in Cupola- Dissolved Gases in Molten Metal, Degassing Methods- Analysis and Composition of the Metal Ladle- Fluxes, Effect of Inoculation.

UNIT III

Pouring and Feeding: Solidification of Metals- Equilibrium Diagram- Feeding Systems- Design of Runners and Risers- Cooling Rates of Different Sections, Casting Defects and Remedies- Stresses in Casting and Relieving Operations.

UNIT IV

Foundry Mechanisation: Moulding- Core Making Sand Conditioning- Removal of Moulds- Pouring Methods- Shake out- Core Cleaning, Fettling, and Handling

Testing: Sand Testing, Moulding Testing- Testing of Casting- Instrument Sand Equipments used for Testing and Inspection.

UNIT V

Advanced Casting Processes: Pressure die casting – Centrifugal – continuous – investment – shell moulding – squeeze – electro slag casting – CO_2 moulding – Plaster Mould castings – Slush casting - Evaporative pattern casting

TEXT BOOKS

1. Campbell, "Casting and Forming Process", McGraw-Hill, 1997.
2. Heine, R.W., Rosenthal, P.C., & Loper, C.R., "Principles of Metal Casting", Tata McGraw-Hill, 1997.

REFERENCES

1. Jain, P.L., "Principles of Foundry Technology", Tata McGraw-Hill, 1997.
2. Merck, "Fundamentals in the Design and Production of Casting", McGraw Hill.
3. Banga, T.R., Agarwal, R.E., and Tahil Manghrani, "Foundry Engineering", Khanna Publishers, New Delhi, 1992.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the basic features and terminologies in casting process, gating and reserving system
2. Gain knowledge on melting furnaces and degassing methods
3. To understand the design aspects and the basics in solidification or the casting formation.
4. Study the types of defects occurred in casting and provide remedial solutions.
5. To obtain knowledge in the advanced casting process

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓				✓				✓
CO5	✓		✓							✓		

MMPC502	METAL FORMING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To familiarize the students the types of stress, in two and three dimensional.
- To provide basic knowledge of secondary processes and condition for manufacturing defect free end-product.
- To illustrate the concepts of various advanced metal forming processes.

UNIT I

State of stress in two dimensions – two and three dimensions - Principal stresses, Stress deviator, Vonmises criteria, yield criteria. Comparison of yield criteria, Forming load calculation - Fundamentals of Metal working: Flow curve, Relationship between true stress and true strain, Temperature in metal forming, hot cold and warm working – residual stresses.

UNIT II

Forging: Types of Process & hammers defects & remedies. Forging classification, open die forging, Closed die forging - calculations of forging loads, Defects - causes - remedies.

Rolling: Rolling of blooms billet, Slab & Sheet, types of rolling mills – hot and cold rolling - forces & geometrical relationship in rolling, Analysis of rolling load, torque & power, defects - causes and remedies.

UNIT III

Drawing of rods, wires & tubes : Simple analysis of wire tube drawing . residual stress in rod, wire & tubes .

Extrusion – classification – hot and cold extrusion – deformation, lubrication - simple analysis of extrusion process - hydrostatic extrusion - tube extrusion, production of seamless pipes and tubes - extrusion defects causes and remedies

UNIT IV

Sheet Metal Forming: Forming methods – shearing and blanking – bending – types of bending – spring back – Deep drawing – Mechanism of Deep drawing – Limiting draw ratio – Concept of Forming Limit Diagram. Description only: Stretch forming – Rubber pad forming – Tube hydro forming – defects in sheet metal forming.

UNIT V

High Speed Forming: Basic principle, process variables, Characteristics and application of the following processes: Electro hydraulic forming, electromagnetic forming, explosive forming, fuel combustion process, water hammer forming. Comparison between conventional forming and high speed forming.

TEXT BOOKS

1. Rowe, G.W., "An Introduction to the Principles of Metal Working", Edward Arnold Publication.
2. George E. Dieter "Mechanical Metallurgy", McGraw-Hill International Edition, Newyork, 1998

REFERENCES

1. Robert H. Wagoner and Jean Loup Chenot., "Fundamentals of Metal Forming", John Wiley & Sons Inc., New York, 1992.
2. Calladine, C.R., "Plasticity for Engineers", John Wiley & Sons, 1991.
3. Metals Handbook, "Material Information Society", ASM, Vol.4, 1979.
4. Rao, P.N., "Manufacturing Technology – Foundry, Forming and Welding", Tata McGraw-Hill, 1998.
5. Davies, R., and Austin, E.R., "Developments in High Speed Metal forming", The Machinery Publishing Co. Ltd., London, 1970.
6. Haslehurst, "Manufacturing Technology", ELBS, 1973.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the stresses and component of stresses
2. Expertise different forming process to manufacture near net- shape product
3. Expertise different types of drawing and extrusion process
4. Gain knowledge on various types of sheet metal forming methods
5. Impart basic knowledge on various high speed forming processes

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓									✓		
CO2			✓	✓								✓
CO3			✓	✓		✓						✓
CO4	✓	✓	✓	✓	✓		✓	✓		✓		✓
CO5	✓	✓	✓	✓	✓		✓	✓		✓		✓

MMPC503	**ENGINEERING METALLURGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To impart fundamental knowledge on the structure, properties, heat treatment, testing and applications of metals and alloys.
- To introduce the concept of powder metallurgy and different type of corrosion.

UNIT I

Constitution of alloys, compounds & solid solutions, Gibbs phase rule, lever rule - Diffusion in Solids, Fick's laws – Solidification, Nucleation and grain growth - constitutional supercooling, formation of dendrites - Directional solidification, Micro segregation, Macro segregation, Porosity and inclusions - Metallography - metallurgical microscope - preparation of specimen, micro & macro examination. Grain size ASTM grain size number, grain size measurement.

UNIT II

Phase diagrams, isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions, Iron - Carbon equilibrium diagram - Classification of steel - Plain carbon steels - effect of C, Mn, Si, P & S. Purpose of alloying, effect of important alloying elements. - Important low alloy steels, stainless steel, tool steels - types, compositions and applications ; Cast iron - types, composition and applications.

UNIT III

Heat treatment of steel: Isothermal transformation diagram - Time Temperature Transformation Diagram, Continuous cooling transformation diagrams, full annealing, stress relief annealing, spheroidzing, normalizing, Hardenability and Jominy end quench test- Austempering and martempering - case hardening, carburising, nitriding, cyaniding, and carbon nitriding, flame hardening, induction hardening, vacuum hardening and cryogenic treatment- Precipitation and Age hardening

UNIT IV

Non ferrous metals: Physical, Mechanical, Metallurgical properties of Aluminum alloys, Magnesium alloys, Copper alloys, Nickel alloys and Titanium alloys – Classification of these alloys and applications.

Powder metallurgy : Process fundamentals, production of metal powders, characteristics, powder blending, compacting, Sintering, applications

Corrosion - Factors influencing corrosion, pitting corrosion, cavitation corrosion, cervice corrosion, fretting corrosion, inter - granular corrosion - corrosion prevention.

UNIT V

Mechanical behaviour of materials: Tensile behaviour: engineering stress, engineering strain, true stress, true strain, Stress – strain curve, Yield point phenomenon, strain aging. Impact behaviour: Charpy and Izod impact testing, DBT curve. Hardness: Brinell hardness, Rockwell hardness, micro hardness testing; Fatigue behaviour: Stress cycles, S-N curves, fatigue crack initiation, fatigue crack propagation; Creep behaviour: creep curve, creep mechanisms, deformation mechanism maps.

TEXT BOOKS

1. Sydney, H., Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill Book Co., 2008.
2. Raghavan, V., "Materials Science & Engineering", Prentice Hall of India Pvt.Ltd, 2015.

REFERENCES

1. George E. Dieter., "Mechanical Metallurgy", McGraw Hill Book Company, New York, 1988.
2. Rollason, E.C., "Metallurgy for Engineers", Butterworth-Heinemann Ltd, 4th Revised edition, 1987.
3. Williams, D., "Material Science and Engineering", Callister Wiley India Pvt. Ltd, Revised Indian edition, 2007.
4. Sinha, A.K., "Powder Metallurgy", Dhanpat Rai & Son, New Delhi, 1995.
5. Raj Narayan, "An Introduction to Metallic Corrosion & its Prevention", Oxford & IBH, NewDelhi, 1983.
3. Higgins, R.A., "Engineering Metallurgy - Part I, Applied Physical Metallurgy", ELBS., 1993.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the correlation between structure and properties of metals and alloys;
2. Select the appropriate alloys for specific applications;
3. Design heat treatment methods for specific applications;
4. Protect the metals and alloys from environmental degradation;

5. Evaluate the mechanical properties of materials by modern tools and equipments.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓				✓					✓
CO2		✓	✓		✓					✓		
CO3			✓	✓								
CO4			✓					✓				✓
CO5				✓	✓			✓	✓			

MMPC504	**MECHANICS OF MATERIALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To gain knowledge of simple stresses, strains and deformation in components due to external loads.
- To assess stresses and deformations through mathematical models of beams, twisting bars or combinations of both.
- To study the effect of component dimensions and shape on stresses and deformations are to be understood.
- The study would provide knowledge for use in the design courses

UNIT I

Define of stress – types of stresses: Direct stress (Tensile and compressive), Bending stress, Shear stress, temperature stress, composite stress – Strains: Linear strain, lateral strain, volumetric strain, temperature strains- Hook's Law- modulus of elasticity- Axial rigidity- Flexural rigidity – Torsional rigidity- poison's ration, stress versus strain diagrams for concrete, timber, mild steel sections, HYSD (High Yield Strength Deformed) bars. Elastic constants relationship- simple problem-Banding stress and strain variations for rectangular sections-Shear stress variations for rectangular sections.

UNIT II

Stain Energy-stain Energy stored in an elastic body due to axial force- Strain Energy stored in an elastic body due to bending – Strain Energy stored in an elastic body due to shear – Strain Energy stored in an elastic body due to torsion- strain Energy stored in an elastic body due to gradually applied loads - Strain Energy stored in an elastic body due to suddenly applied loads or impact load-Stress at a point – stress tensor- Equations of Equilibrium-Uni-axial state of stress-Stresses on a plane-Transformation of plane stress- Principle stresses and maximum shear stress-Mohr's Circle for plane stress.

UNIT III

Loads: Gravity and lateral loads, concentrated loads, uniformly distributed loads, Beams: Cantilever beams, simply supported beams, single and double over hanging beams support Conditions: removed hinged support, Roller support and load and reactions –Bending moments and shear force diagrams-points of contra flexure-Variation of bending stress for rectangular and circular sections-section modulus-neutral axis- Moment resistance. Simple bending Theory (Euler Bernoulli Theory) – Deflection of determinative beams-Strain Energy methods-Double Integration Methods-Macaulay's Methods.

UNIT IV

Torsion-Theory of pure torsion in circular shafts-Variation of shear stress distribution across the solid (Circular), Hollow (Circular), and thin walled sections-saint venant's torsion-warping torsion- Torque transmitted in circular and hollows shaft

Spring-stiffness-linear stiffness and rotary stiffness-types: Helical (Open coiled, close coiled) and leaf spring uses – spring in series and – spring in parallel – load versus deformation ship-spring deflections. Stiffness and shear stress. – Automobile springs

UNIT V

Simple machines-inclined plane- Law machine-Effort and load lifted- Mechanical advantages and Efficiency- Ideal machine-Levers – Wedges-screw jack-Gears- Belts-pulleys-wheel and Axle-Differential pulleys-Worm and wheel-Handle winch.

TEXT BOOKS

1. Bansal. R.K., "A text Book on Engineering Mechanics", Lakshmi Publications, New Delhi, 2005.
2. Sadhu Singh. P., "Strength of Materials", Khanna Publishers. 1990.

REFERENCES

1. Timoshenko, S., and Young, D.H., "Strength of Materials", East west Press New Delhi, 1968.
2. Rajput, R.K., "Strength of Materials", S. Chand Company, New Delhi, 1999.
3. Nash, W.A., "Strength of Materials", Schaums series - McGraw-Hill Publishing company, 1989.
4. Ramamrutham, S., "Strength of Materials", Dhanpat Rai and sons, New Delhi, 1986.

COURSE OUTCOMES

Upon completion of the course, the student should be able to:

1. Develop knowledge on identifying stress, strain and their effects
2. Understand the theory of various types of loading systems
3. Critically analyses components like beams and twisting bars
4. Understand theories on columns and springs
5. Employ all the knowledge gained in designing of machine components.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓							✓		✓
CO2	✓		✓							✓		✓
CO3	✓	✓										
CO4	✓				✓					✓		
CO5	✓		✓									

MMCP507	**METAL FORMING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To educate the importance of various process parameters during metal forming processing methods such as rolling water hammer forming.

- To learn to plot the stress strain curve of compression and tension testing
- To provide hands-on experience on preparing various types of green sand mould.

LIST OF EXPERIMENTS

1. Formability of sheet metals by water hammer technique
2. Rolling of metal strips
3. Disc compression test
4. Estimation of creep rate of a given specimen
5. Uniaxial tensile test
6. Charpy impact test
7. Izod impact test

Foundry Shop – Green sand mould preparation using the following patterns

8. Face Plate (Solid Pattern)
9. Hexagonal Nut (Self Core solid Pattern)
10. Lathe Saddle (Loose Piece Pattern)
11. Oil Cup (Self Core solid Pattern)
12. Ball Handle (Split Pattern)
13. Pipe Flange (Split Pattern)
14. Pulley (Split Pattern)
15. Gear wheel (Solid Pattern)

COURSE OUTCOMES

Upon completion of the course, the student should be able to:

1. Determine tensile parameters
2. Understand the parameters that influencing various material processing methods.
3. Prepare green sand moulds of given pattern.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓	✓							✓	
CO2	✓	✓		✓					✓			✓

MMCP508	**METALLURGY LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To study the Microstructure of ferrous non-ferrous and heat treated specimens etc.
- To learn to construct phase diagram
- To study effect of section size and quenching media on hardness

LIST OF EXPERIMENTS:

1. Effect of section size on hardness
2. Effect of quenching media on hardness
3. Jominy hardenability test
4. Microscopic examination of a metallic specimen and determination of grain size
5. Micro-structural study of ferrous material
6. Micro-structural study of non-ferrous material

7. Micro-structural changes of a heat treated specimen
8. Micro-structural changes at the heat effected zone of a welded specimen
9. Identification of materials by spark test
10. Phase diagram
11. Estimation of creep rate
12. Characteristics of moulding sand
13. Corrosion test

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

1. Differentiate the Microstructure of ferrous non-ferrous and heat treated specimens etc.
2. Construct phase diagram
3. Understand the effect of section size and quenching media on hardness

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓							✓			
CO2			✓		✓					✓		
CO3	✓	✓		✓								✓

MMCP509	**STRENGTH OF MATERIALS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To impart practical training on simple machines like screw jack, worm wheel, etc.,
- To understand the theoretical and practical aspects of elasticity and plasticity of the materials through a variety of experiments

LIST OF EXPERIMENTS

1. Simple Machines - screw jack, worm and wheel, differential wheel and Axle, Handlowinch
2. Material Testing - Tension, compression and shear tests on different materials
3. Bending and deflection test on beams
4. Hardness, impact and ductility tests on metals
5. Torsion tests on rods, springs and fatigue tests (Demonstration only)

COURSE OUTCOMES

Upon completion of the course the students will be able to

1. Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
2. Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.
3. Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓										
CO2	✓		✓						✓			✓
CO3	✓	✓		✓							✓	

MMPC601	**MECHATRONICS FOR AUTOMATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To provide basic knowledge about functioning of different control systems, the mechanical and electrical actuation systems.
- To familiarize the students the performance of different types of sensors and transducers, the principle of signal conditioning.
- To illustrate the concepts real time interfacing and advanced application and data acquisition and control systems of mechatronics in manufacturing.

UNIT I

Introduction & Actuation systems: Introduction to Mechatronics System - Elements of measurement system - control systems - open and closed loop - sequential controllers - microprocessor based controllers - Mechatronics approach.

Electrical actuation systems - electrical system - mechanical switches: solid state switches - solenoids - A.C. - D.C Motors - stepper motors.

UNIT II

Mechanical actuation systems - Types of motion - Kinematic chains - cams gear trains - ratchet and pawl - belt and chain drives - bearing - mechanical aspects of motor selection: Pneumatic and hydraulic actuation systems - directional control valves - pressure control valves - cylinders - process control valves - rotary actuators.

UNIT III

Sensors and Transducers- Performance terminology - static and dynamic characteristics - types - displacement, position and proximity sensors - velocity and motion - fluid pressure - temperature sensors - light sensors - Micro sensors in mechatronics; Signal conditioning- operational amplifier - protection - filtering - wheat stone bridge; digital signals - multiplexers - data acquisitions - data signal processing - pulse modulation.

UNIT IV

Systems and control: Introduction - system representation - Transfer function form - block diagram form - time delays - measurement of system performance - stability - accuracy - transient response - sensitivity. Elementary ideas on control modes, PID controller, digital controller, velocity control, adaptive control – Programmable logic controller, velocity control, adaptive control - Programmable logic controller - basic structure - ladder diagram.

UNIT V

Real time interfacing and advanced application: Real time interfacing with computer - elements of data acquisition and control system - overview of I/O process. Application - Sensors for conditioning monitoring – mechatronics control in automated manufacturing -

online quality monitoring - monitoring of manufacturing processes - supervisory control in manufacturing - inspection - integration of heterogeneous system - artificial intelligence in mechatronics.

TEXT BOOKS

1. Bolton,N., "Electronic Control System for Mechanical and Electrical Engineering Mechatronics", Longman, 1995.
2. Mechatronics, HMT. Tata McGraw-Hill, 1998.

REFERENCES

1. Daradaly, D.A., Dawson, D., "Mechatronics - Electronics in Products & Processes", Burd. N.C. & Hall, 1993.
2. Electro Mechanics - Principles Concepts and Devices Prentice Hall, 1995.
3. Mechatronics system Design - PWS Publishing Company, 1998.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the elements of mechatronic system
2. Understand the construction and working principles mechatronic control systems, Electrical and Mechanical actuation systems.
3. Distinguish between sensors and Transducers.
4. Identify suitable mechatronics control system for manufacturing processes.
5. Develop new mechatronics control system for different manufacturing processes

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓	✓							✓
CO2	✓				✓							
CO3	✓			✓	✓						✓	
CO4				✓	✓				✓			
CO5				✓	✓					✓		✓

MMPC602	**FLUID MECHANICS & MACHINERY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To study the applications of the conservation laws to flow through pipes and hydraulic machines.
- To understand the importance of dimensional analysis.
- To understand the importance of various types of flow in pumps and turbines

UNIT I

Introduction to fluid mechanics -Real and ideal fluids – Properties of fluid – Pressure in a fluid – Manometers — compressible and incompressible fluids – Pressure measurements — Hydrostatic forces on surfaces -Total pressure and Centre of pressure on different surfaces – Buoyancy and static stability – Metacentre.

UNIT II

Types of flows and flow pattern (stream lines, stream tube, Path lines and streak line)– one dimensional flow analysis – General continuity equation – steady flow equation of continuity – Euler's equation- Bernoulli's equation and its applications.(Orifice meter, Venturimeter and pitot tube).

UNIT III

Boundary layer – laminar and turbulent flow separation – Transition- types of Boundary layer thickness – Flow through pipes- Weisbach equation and chezy's for friction loss in pipe- Major and minor losses – Buckingham ∏ theorem – non – dimensional numbers – Reynolds number – Froude numbers, Weber number, Euler's number and Mach number.

UNIT IV

Pressure of a jet a stationary and moving curved blades – impulse and reaction turbines – Pelton wheel – velocity diagram for impulse turbine – hydraulic, mechanical and overall efficiency – reaction turbines – types – Francis and Kaplan turbine – velocity diagrams – draft tubes – specific speed – cavitation.

UNIT V

Centrifugal pump – casing – velocity diagrams – manometric and hydraulic efficiency – minimum speed for starting a pump – specific speed. Reciprocating pump – slip and co-efficient of discharge – velocity diagrams – effect of friction and velocity & acceleration on pipes – air vessels – hydraulic appliances.

TEXT BOOKS

1. Bansal, R.K., "A Text Book of Fluid Mechanics and Hydraulic Machinery", Lakshmi Publications, Madras.
2. Modi, P.N., "Hydraulics and Fluid Mechanics", Seth S.M Standard Book House, NewDelhi, 1992.

REFERENCES

1. Khurmi, R.S., "Fluid Mechanics and Hydraulics Machinery", S. Chand and Co. New Delhi, 1991.
2. Jagdish Lal, "Fluid Mechanics and Hydraulics Machines", Metropolitan Book Co. Pvt. Ltd., New Delhi, 1991.
3. Kumar, K.L., "Engineering Fluid Mechanics", Eurasia Publishing House (p) Ltd. New Delhi (2004).

COURSE OUTCOMES

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

1. Apply mathematical knowledge to predict the properties and characteristics of a fluid.
2. Critically analyse the performance of pumps and turbines.
3. Identify hydraulic component
4. Ability to design hydraulic circuits
5. Visualize how the hydraulic circuit will work to accomplish the function.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓										
CO2	✓	✓	✓	✓					✓		✓	✓
CO3	✓											
CO4	✓		✓	✓					✓			
CO5	✓		✓	✓					✓	✓		✓

MMCP607	DESIGN & AUTOMATION LABORATORY (CAD/CAM)	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To impart hands on experience to students in Geometric Modeling, Assembly and Engineering Drafting.
- To introduce the concepts of CNC programming and simulation on CNC turning, CNC Milling machines
- To provide hand on experience in the use of hydraulic & pneumatic components.
- To formulate simple circuits which enable the students to understand the concept of mechatronics.

LIST OF EXPERIMENTS

Creo:

1. Sketcher
2. Solid modeling
3. Surface modeling
4. Feature manipulation
5. Assembly
6. Drafting

Mechatronics:

7. Study of various pneumatic and electro-pneumatic components.
8. Study of pneumatic and electro-pneumatic symbols, circuits.
9. Study of PLC, Ladder Diagram and its applications.
10. Study of characteristics of sensors.
11. Study of image processing technique.
12. Modelling and analysis of pneumatic and electrical circuits using FluidSim/P Software.
13. Application on Pneumatics
14. Application on Electro Pneumatics
15. Application on Programming Logic Control (PLC)

COURSE OUTCOMES

Upon successful completion of the course, the students are able to

1. Gain practical experience in handling 2D drafting and 3D modeling using modeling software systems.
2. Understand and apply the concepts G and M codes and manual part programming of turning and milling processes
3. Understand the functional aspects of different pneumatic and hydraulic components and its use in circuits.
4. Construct and demonstrate pneumatic, electro pneumatic and PLC circuits for various applications

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓									
CO2	✓				✓				✓		✓	
CO3		✓										✓
CO4	✓	✓							✓	✓		✓

MMCP608	**HYDRAULICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To understand the properties of fluids and fluid statics, methods for determination of co-efficient of discharge.
- To study of the characteristic features of pumps and turbines.
- To understand the significance and role of such utilities in their further course of study.

LIST OF EXPERIMENTS

1. Determination of Co-efficient of discharge of Mouth Piece
2. Determination of Co-efficient of discharge of Venturimeter
3. Determination of Co-efficient of Head loss due to Sudden Change in Section
4. Determination of Co-efficient of Head loss due to Friction in Pipe
5. Determination of Co-efficient of discharge of Rectangular Notch
6. Study of Performance characteristics of Elmo Pump (Centrifugal Pump)
7. Study of Performance characteristics of Sump Pump (Centrifugal Pump)
8. Study of Performance characteristics of Submersible Pump (Centrifugal Pump)
9. Study of Performance characteristics of Gould's Pump (Reciprocating Pump)
10. Study of Performance characteristics of Pelton Turbine (Constant Speed method)
11. Study of Performance characteristics of Francis Turbine (Constant Head method)
12. Determination of Metacentric Height of a floating vessel (Demo Only)

COURSE OUTCOMES

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

1. Determine the properties of fluids, pressure and their measurements
2. Measure flow in pipes and determine frictional losses
3. Compute forces on immersed plane and curved plates applying continuity equation and energy equation in solving problems on flow through conduits
4. Develop Characteristics of pumps and turbines

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓									✓	
CO2		✓	✓				✓					
CO3		✓	✓		✓					✓		✓
CO4			✓								✓	

ETHS701	ENGINEERING ETHICS	L	T	P	C
		3	0	0	2

COURSE OBJECTIVES

- To understand the moral and ethical dimensions in engineering.
- To take balanced decisions.

UNIT I

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.

UNIT II

Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study.

UNIT III

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal.

UNIT IV

Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V

Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct

TEXT BOOKS

1. Govindarajan M, Natarajan S and Senthilkuma, V S, "Professional Ethics And Human Values", PHI Learning, New Delhi, 2013.
2. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York, 2005.

REFERENCES

1. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Thompson Learning, 2000.
2. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, 2003.
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, 2001.
4. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003).

COURSE OUTCOMES

Upon successful completion of the course, the students are able to

1. Understand the relationship between the engineer and the society.
2. Learn the importance of codes in engineering practice.
3. Acquire knowledge on the legal aspects in engineering.
4. Acquire knowledge on the moral and ethical aspects in engineering.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓					✓						
CO2			✓			✓		✓	✓			✓
CO3			✓			✓				✓		
CO4			✓			✓				✓		

MMPC702	**DESIGN OF MACHINE ELEMENTS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To familiarize the various steps involved in the Design Process
- To understand the principals involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components

UNIT I

Introduction: Types of Design factors. Factor of safety , Theories of failure - Curved beam, crane hook and C frames.

Design for fatigue strength: S-N diagram - Endurance limit modifying factors - Stress concentration - Fluctuation stress – Soderberg & Good Man equations

UNIT II

Thin cylinders – Stresses in thin cylindrical shell due to internal pressure – circumferential and longitudinal stresses and deformation in thin cylinders Design of mechanical elements: Shafts – Design for static load – bending and torsion – Equivalent twisting moment**.** Coupling - Types - Design and selection of coupling - Flange coupling, Bushed pin type, flexible coupling design and selection

UNIT III

Theory of columns: Design of push rod, piston rod and I.C. Engine connecting rods sections.

Wire ropes - Stresses - selection Design procedure–leaf springs - construction equalized stresses in leaves - material and design. Open and closed coiled helical springs stress - Wahl's factor

UNIT IV

Power screws - Thread forms Design consideration and materials - wear and shear - design procedure. Threaded fasteners – Bolted joints – simple and eccentrically loaded bolted joints

UNIT V

Design of Joints: Riveted Joints: Introduction - Types of riveted joints - failures of a riveted joint - strength and efficiency - Design of boiler joints.

Welded joints: Introduction - Strength of transverse and parallel fillet welded joints - Axially loaded unsymmetrical welded sections - Eccentrically loaded welded joints

TEXT BOOKS

1. Khurmi, R.S., "Machine Design" , S. Chand and Company Ltd., New Delhi, 14th edition, 2005.
2. Pandya, and Sha., "Machine Design", Charotar Publisher, house, Anand, India

REFERENCES

1. Richard Budynnas, J.E.Shigley's, "Mechanical Engineering Design", McGraw-Hill Book Company, 8th ed.,2008
2. Prabhu, T.J., "Fundamentals of Machine Design", Scitect Publisher 4th edition, 2000.
3. Sundararajamoorthy, T.V., and N. Shanmugam, "Machine Design", Anuradha Agencies, 2000.

COURSE OUTCOMES

Upon completing this course, students should be able to

1. To understand the basics of engineering design of machine elements
2. To understand the functions of various machine elements and assemblies
3. To design various machine components according to the requirement as per the prescribed standards
4. To apply the knowledge of materials and their properties
5. To use standard design data book

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓	✓							✓
CO2	✓											✓
CO3	✓		✓	✓								
CO4		✓	✓							✓		
CO5	✓											✓

MMCP706	**MACHINE DRAWING**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To provide basic understanding of machine drawing.
- To study the provide assembly and disassembly drawings of bearings, screw jack ect.

UNIT I

Fasteners: Different form of rivet heads – Single, double riveted lap and butt joints - Foundation bolts - Locking arrangements for nuts - lock nut, split pin, locking plate and spring washer - Stud Set screws – Different forms of machine screws - pan, countersunk, slotted and philip headed screws - Keys - sunk taper key, gib headed taper key, feather key, woodruff key, saddle key.

UNIT II

To draw orthographic views from the given isometric views of simple objects. Detailed assembly drawing and additional views from the given drawing.

(a) Shaft coupling - Protected type and Pin type flexible coupling
(b) Bearings and Supports - Bushed bearing, Foot step bearing and Plummer Block
(c) Eccentric
(d) Steam engine stuffing box
(e) Screw jack.

TEXT BOOKS

1. Gopalakrishna K.R., Machine Drawing, Subhas stores, Bangalore.
2. Bhatt N.D., Machine Drawing, Charotar Publishing House.

REFERENCES

1. Parkinson A.C.(Sinha), A First Year Engineering Drawing, Wheeler Publishers, New Delhi.
2. Parkinson A.C., Intermediate Engineering Drawing.
3. Narayana K.L., Kanniah P & Venkata Reddy K., A text book on Production Drawing, Premier Publishing House, Hydrabad.
4. Narayana K.L., Kanniah P. & Venkata Reddy K., Machine Drawing, New Age International (P) Limited, Publishers.
5. Lakshmi Narayanan V & Mathur M.L., A Text Book of Machine Drawing, Jain Brothers Publishers.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. An Ability to understand and apply the knowledge of machine drawing as a system of communication in which ideas are expressed clearly and all information fully conveyed.
2. An ability to understand the design a system, component or process to meet desired needs within, realistic constraints such as manufacturability, economic, environmental, safety & sustainability etc.., to represent a part drawing and assembly drawings.
3. Recognition of the need for and an ability to engage in self education and life-long learning.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓					✓					✓
CO2	✓	✓					✓				✓	
CO3	✓				✓				✓			

MMST707	**SEMINAR / INDUSTRIAL TRAINING**	**L**	**T**	**P**	**C**
		0	**1**	**2**	**2**

COURSE OBJECTIVES

- To expose students to the 'real' working environment and get acquainted with the organization structure, business operations and administrative functions.

- To have hands-on experience in the students' related field so that they can relate and reinforce what has been taught at the university.
- To promote cooperation and to develop synergetic collaboration between industry and the university in promoting a knowledgeable society.
- To set the stage for future recruitment by potential employers.

The student has to present a seminar on the chosen topic. However, the student can select a topic duly approved by the Seminar Coordinator and the Head of the Department concerned. The student who has presented the seminar has to submit a report and appear for viva-voce examination at the end of the semester conducted by faculty members nominated by head of the department.

For Industrial training, the student has to undergo training in a reputed industry for 15 days and has to submit a report on completion of the training. The report will be evaluated by a team of faculty members nominated by the head of the department.

COURSE OUTCOME

Upon completion of the Training, students will have the

1. Ability to work in a team
2. Ability to take initiatives.
3. Ability to effectively communicate solution to problems (oral, visual, written).
4. Ability to manage a project within a given time frame.
5. Ability to apply prior acquired knowledge in problem solving.
6.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓					✓	✓		✓	✓		✓
CO2	✓					✓	✓		✓	✓		✓
CO3	✓					✓	✓		✓	✓		✓
CO4	✓					✓	✓		✓	✓		✓
CO5	✓					✓	✓		✓	✓		✓

MMPV803	**PROJECT WORK AND VIVA-VOCE**	**L**	**T**	**P**	**C**
		0	**8**	**4**	**10**

COURSE OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Take up any challenging practical problems and find solution by formulating proper methodology.
2. Students will acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
3. Students will acquire collaborative skills through working in a team to achieve common goals.
4. Students will be able to learn on their own, reflect on their learning and take appropriate actions to improve it.
5. Students will acquire the skills to communicate effectively and to present ideas clearly and coherently to specific audience in both the written and oral forms.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓			✓		✓			✓
CO2	✓	✓	✓	✓			✓		✓			✓
CO3	✓	✓	✓	✓			✓		✓			✓
CO4	✓	✓	✓	✓			✓		✓			✓
CO5	✓	✓	✓	✓			✓		✓			✓

PROFESSIONAL ELECTIVE COURSES

MMPESCN	**NON-TRADITIONAL MANUFACTURING PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the fundamentals of Non-Traditional Manufacturing Processes and their methods, applications advantages and disadvantages
- To introduce the concept of nano technology and rapid prototyping

UNIT I

Overview of non-traditional manufacturing – classification of processes under source of energy, transfer media and mechanism

Electric Discharge Machining (EDM): Principles – equipment – power supply, dielectric system, electrodes – process parameters – applications

Wire Electric Discharge Machining (WEDM): Principles – equipment – power supply, dielectric system, electrodes – process parameters – applications

UNIT II

Abrasive Jet Machining (AJM): Principles – equipment – abrasives – nozzles– process parameters – applications

Abrasive Flow Machining (AFM): Principles – equipment – tooling – media – process parameters – applications

Water Jet Machining (WJM): Principles – equipment – nozzles – process parameters – applications
Abrasive Water Jet Machining (AWJM): Principles – equipment – nozzles – Abrasive feed system – process parameters – applications

UNIT III

Ultrasonic machining (USM): Principles – equipment – transducers – tool horns – abrasives, abrasive slurry – process parameters – applications
Electro chemical machining (ECM): Principles – equipment – electrolytes – tools – process parameters – applications
Chemical machining (CHM): Principles – equipment – masks, etchants – process parameters – applications

UNIT IV

Electron Beam Machining (EBM): Principles – equipment – EB gun – power supply – process parameters – applications
Laser Beam Machining (LBM): Principles – equipment – power supply – process parameters – applications
Plasma Arc Machining (PAM): Principles – equipment – plasma torches – process parameters – applications Hot machining – Neutral particle technique – High speed machining.

UNIT V

Basic Principle of Nano technology - Rapid prototyping: basic concepts, techniques: Stereolithography, Selective Laser Sintering, Selective Powder Binding, Fused Deposition Modeling, Laminated Object Manufacturing – applications

TEXT BOOKS

1. Pandey, P. C., and Shan, S. H., "Modern manufacturing processes", Tata McGraw Hill Pub. Co. Ltd., New Delhi
2. Amitabha Ghosh, "Rapid prototyping – A Brief Introduction", East-West Press Ltd.

REFERENCES

1. Gary F. Benedict, "Non-Traditional Manufacturing Processes", Marcel Dekker, Inc., New York.
2. Amitabha Ghosh and Ashok Kumar Mallik, "Manufacturing Science", Affiliated East-West Press Pvt. Ltd.
3. Adithan, M.S., "Modern Machining Methods", Chand & Co. Ltd., New Delhi, 1990.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. To understand the need for non-traditional manufacturing processes.
2. To gain knowledge on principle of various non-traditional manufacturing processes
3. Provide better knowledge on the concepts non-traditional manufacturing processes
4. Understand the basic principles of nano technology.
5. Understand the basic principles of rapid proto typing.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓										
CO2					✓							✓
CO3	✓			✓	✓			✓				
CO4	✓			✓	✓			✓				
CO5	✓			✓	✓			✓				

MMPESCN	**TOOL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce different production tools, including press tools, their design.
- To provide an understanding of design and use of jigs and fixtures.

UNIT I

Design principles of cutting tools – problems in cutting tool design – factors in tool design -. Single point cutting tool – chip breakers – determination of tool shank dimensions. Milling cutters – determination of number of teeth, teeth size and other features. Design features – drills – reamers - broaching tools

UNIT II

Press tool design: Press classification – selection and features press. Dies – types – clearances. Progressive die design for typical components for blanking and piercing – compound die –combination die. Strip layout design – influencing factors

UNIT III

Bending: Types of bending – determination of bending force – bend allowance – Springback. Drawing dies: Design of dies – blank development – Cup drawing - illustrative examples.
Ironing – calculation of number of draws. Design of forging dies – blank size. Materials for die block.

UNIT IV

Elements of Jigs and Fixure – Locating and clamping principles. Locating method and devices – Clamping devices. Types of Jigs: Plate, Template, Latch, Channel Leaf, Box and Indexing.

UNIT V

Modular work holding systems – POKA YOKE - quick change toolings - single minute exchange of dies – Computer aided fixture design – phases.
Plastic tooling – Plastic tool materials – construction methods – applications.

TEXT BOOKS

1. Sharma, P.C., "A Text Book of Production Engineering", S.Chand Publisher, 2001.
2. Donaldson, G.H., Lecain, and Goold, V.V., "Tool Design", Tata McGraw-Hill, 2000.

REFERENCES

1. Rodin, P., "Cutting Tool Design", MIR Publisher, Moscow,1968.
2. Wilson, F.W., "Die design Hand book", McGraw Hill.
3. Wilson, F.W., "Fundamentals of Tool Design", ASTME, Prentice Hall, 1974.

COURSE OUTCOMES

Upon completing this course, students should be able to

1. Develop an understanding of the cutting tool nomenclatures
2. Develop and design of progressive and compound dies for simple sheet metal operations
3. Calculate bending force, number of draw for the required cup shape, blank size for forged components.
4. Understand the modern techniques of tool engineering and the various phases in computer aided fixture deign
5. Acquire knowledge about the plastic tool materials and development methods

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓											✓
CO2		✓				✓				✓		
CO3			✓									
CO4	✓			✓								
CO5	✓	✓							✓		✓	✓

MMPESCN	**COMPUTER INTEGRATED MANUFACTURING SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To familiarize the basic concepts of CAD / CAM / CIM
- To introduce the various aspects of automated manufacturing
- To introduce the fundamentals of materials handling and storage system and robotics
- To introduce the concepts of automated assembly and control system

UNIT I

Product design & CAD, CAM, CAD/CAM and CIM – CIM Hardware and Software – Three Step Process for Implementation of CIM – Production Concepts and Mathematical Models Covering Production Rate, Manufacturing Lead Time, Capacity Utilization, Availability & WIP – Automation – Reason for Automation and Automation Strategies

UNIT II

Basic Elements of an Automated System – Advanced Automated Functions – Levels of Automation - Fundamentals of Automated Production Lines – Work Part Transfer Mechanisms – Storage Buffers – Control of the Production Line – Application to Machining System Material Handling and storage system: Overview of Materials Handling Equipment – Conveyors – Automated Guided Vehicle System: Types, Guidance Technology, Vehicle Management – Automated Storage and Retrieval Systems

UNIT III

Industrial Robots: Definition – Robot Anatomy – Types and Classifications – Work Envelope – Co-ordinate Systems – Notations – End Effectors: Grippers and Tools – Robot Sensors and Machine Vision System – Robot Work cell – Robot programming – Robot Applications – Recent developments

UNIT IV

Group Technology: Definition – Part Families – Visual – Parts Classification and Coding – Case Studies In Coding – Production Flow Analysis – Composite Part Concept – Benefits of GT – Application of GT – Cellular Manufacturing Flexible Manufacturing System (FMS): Definition – Types of FMS – FMS Components – Workstations – FMS Layout – FMS Application and Benefits

UNIT V

Automated Assembly: Fundamentals – System Configuration, Part Delivery at Work Station – Design For Automated Assembly - Computer Process Monitoring, Direct Digital Control, Supervisory Control – Distributed Control System and Personal Computer

Short Floor Control: Three Phases – Factory Data Collection – Manual Method – Automated and Semi-Automated Data Collection (ADC) – Bar Code Technologies and Other ADC Technologies.

TEXT BOOKS

1. Mikell P. Groover, "Automation, Production Systems and Computer-integrated Manufacturing", 2nd Edition, Prentice Hall of India Private Limited, New Delhi, 2007.
2. Mikell P. Groover, Weiss, M., Nagel, R.N., and Odrey, N.G., "Industrial Robotics: Technology, Programming and Applications", McGraw-Hill Book Company, New Delhi,

REFERENCES

1. Radhakrishnan, P., Subramanyan, S., and Raju,.V,, "CAD/CAM/CIM", New Age International Publishers, 2000.
2. Yorem Koren, "Computer Integrated Manufacturing", McGraw-Hill, 2005.
3. Rao, P.N, "CAD/CAM - Principles and Applications", Tata McGraw-Hill Publications, 2007.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Provide engineering knowledge on the importance of CAD / CAM / CIM
2. Understand the various aspects of automated assembly and control system
3. To understand the basics of Industrial robots in modern manufacturing
4. Provide knowledge on the concepts of group technology and flexible manufcturing
5. Understand the usage of modern materials handling and storage system and industrial robots

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓									
CO2		✓									✓	
CO3	✓	✓	✓	✓	✓				✓			✓
CO4	✓	✓	✓	✓	✓				✓			✓
CO5				✓		✓			✓			✓

MMPESCN	**COMPUTER AIDED PRODUCT DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the concepts and applications of CAD
- To introduce the various concepts and techniques used for Product design.
- To develop product design skills.

UNIT I

Introduction to Engineering Design – Various phases of systematic design – sequential engineering and concurrent engineering – Computer hardware & Peripherals – software packages for design and drafting.

UNIT II

Computer graphics – applications – principals of interactive computer graphics – 2D 3Dtransformations – projections – Beziercurves, B-Spline and NURBS – Concepts.

UNIT III

Geometric Modeling – types – Wire frame surface and solid modeling – Boundary Representation, constructive solid geometry – Graphics standards – assembly modeling – use of software packages

UNIT IV

Product modeling – types of product models; step of product design product development process tools –Design for reliability – design for manufacturability – machining, casting, and metal forming –Design for environment; Bench marking – FMEA - Design for product life cycle.

UNIT V

Product Data Management – concepts – roles and responsibility Collaborative product design and commerce – Information Acquisition – Sourcing factor – manufacturing planning factor – Customization factor – Product life cycle management.

TEXT BOOKS

1. Ibrahim Zeid, “CAD/CAM theory and Practice”, Tata McGraw Hill.
2. Radakrishan, P., Subramaniyan, S., and Raju, V., “CAD/CAM/CIM “, New age International (p) Ltd. Publishers.

REFERENCES

1. Biren Prasad, "Concurrent Engineering Fundamentals", Prentice Hall.
2. James G. Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill. David, F., Rogers. J, Alan Adams, "Mathematical Elements for Computer Graphics", McGraw Hill.
3. Kevin Otto and Kristin Wood, "Product Design", Pearson Education.

COURSE OUTCOMES

1. Upon completing this course, students should be able to:
2. Understand fundamentals of 2D and 3D drawing.
3. Able to apply Geometric modeling principles of design.
4. Able to manage the product data and apply product life cycle management to Industrial Components.
5. Understand and apply the product modeling.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓											
CO2		✓	✓								✓	
CO3				✓								
CO4						✓		✓				✓
CO5		✓	✓	✓							✓	

MMPESCN	**PRODUCTION AND OPERATIONS MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To provide an understanding of the modern approaches to manage the operations,
- To present a broad conceptual framework for the management of the operations function in an organization

UNIT I

Production and operation management – Evolution and objectives - Concept of Production system - Types of Production systems – Continuous, Intermittent -Elements of Production planning and control, concept of Productivity - Production versus Services. Aggregate planning: Costs, Strategies – Application of chase and level strategies and Transportation model - Simple problems.

UNIT II

Capacity planning: Defining and measuring capacity –determinants of effective capacity –Developing capacity alternatives.

Forecasting - components of demand - Quantitative methods - Single moving average method - Single exponential smoothing method - Simple linear regression model –- Measures of accuracy - Illustrative examples - Qualitative Methods.

UNIT III

Inventory planning and control: Need, inventory costs, Determination of EOQ, EPQ/ELS (without shortages) - Effect of quantity discounts. Determination of ROL, Safety

Stocks - Methods of calculating safety stock using Normal - single period inventory model, Inventory control systems - P, Q, and S-s System.

UNIT IV

Materials Requirements Planning (MRP) - Master Production Schedule (MPS), Bill of Materials (BOM), MRP concept, Lot sizing: Lot-for-lot technique, EOQ approach, Periodic order quantity approach – Illustrative Examples.

UNIT V

Operations scheduling and sequencing: Notations and definitions - Job shop scheduling: sequencing of n jobs through one machine - Priority decision rules – Measures of Performance - n jobs through 2 machines - Jackson's rule. Flow shop scheduling: sequencing of n jobs through 2, 3 machines, Johnson's rule. n jobs through m machines - CDS algorithm.

TEXT BOOKS

1. Pannerselvam, R., "Production and Operations Management", PHI Learning Pvt. Ltd., 2008.
2. Charry, S.N., "Theory and Problems in Production and Operations Management", Tata McGraw-Hill, 2005.

REFERENCES

1. Joseph G. Monks, "Theory and Problems of Operations Management", Tata McGraw-Hill Publishing Company Limited, 2nd Edition, 2004.
2. Anil Kumar, S., and Suresh, N., "Production and Operations Management", New Age International (P) Limited Publishers, 2nd Edition, 2008.
3. Everett E. Adam, and Jr.Ronald J.Ebert, "Production and Operations Management", Prentice-Hall of India Private Limited, 5th Edition, 1994.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Develop an understanding of various types of production systems
2. Differentiate Production and services
3. Gain an understanding and appreciation of the principles and applications relevant to the planning, design, and operations of manufacturing/service firms
4. Develop the ability to identify operational methodologies to assess and improve an organizations performance
5. Gain ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making in the areas such as Aggregate planning, Inventory control, forecasting MRP and scheduling

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓											
CO2	✓										✓	
CO3			✓									
CO4			✓									✓
CO5					✓							

MMPESCN	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To provide an understanding of modern techniques and tools of quality management
- To impart the knowledge and on the application of the statistical quality control techniques which are used in manufacturing and service industries.
- To provide knowledge and understanding of the modern manufacturing strategies and to present a broad conceptual framework for the management of the operations function across the supply chain.

UNIT I

Concepts of TQM – Definition of quality – Dimensions of quality - Deming, Crosby and Juran's philosophies – Barriers to TQM - Quality system – ISO 9000:2000 - ISO 14000 – QS 9000 Quality system standards - Quality costs, Seven tools for Quality Control, Seven tools for Quality management, Quality Function Deployment (QFD) - Taguchi Loss function.

UNIT II

Objectives of statistical quality control - inspection and its importance – Introduction to Single sampling plan – OC Curve - differences between inspection and quality control - Causes and types of variations - Theory of control charts, Control charts for attributes - p, np, c and u charts.

UNIT III

Control charts for variables, X - $\overline{R}$ charts, standard deviation charts - Moving range chart. Relationship between statistical control limits and specification limits - modified control chart, process capability studies (Cp and Cpk) – concept of six sigma.

UNIT IV

Business Process Re-engineering (BPR) – basic concepts – Bench marking: Types – reasons – process of bench marking – overview and approaches to Concurrent engineering – Agile and Lean manufacturing – FMEA – FMECA.

UNIT V

Technology management – Strategic Management – Goal – Vision – Mission statements – order winner – order qualifier - Decision support systems (DSS) – Manufacturing flexibility – Enterprise wide information system (EWIS) – Enterprise resource planning (ERP) – selection of ERP – Product development – SWOT analysis – Value stream mapping – Customer relationship management (CRM) – Database management system (DBMS) – Re-manufacturing.

TEXT BOOKS

1. Montgomery, D.C., "Introduction to Statistical Quality Control", John Wiley, 1994.
2. James Evans, "Managing for Quality and Performance Excellence", CENGAGE Learning, 2014.

REFERENCES

1. Gupta, R.C., "Statistical Quality Control", Khanna Publication, 1998.
2. Besterfield, "Total Quality Management", Pearson Education, 2nd Edition, 2003.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the core features of the Total quality management in terms of various dimensions of quality.
2. Measure the cost of poor quality and process effectiveness and efficiency to track performance quality and to identify areas for improvement
3. Develop an understanding on quality management philosophies and frameworks
4. Develop the ability to apply the tools of quality control and quality management.
5. Understand proven methodologies to enhance management processes, such as benchmarking and business process reengineering, lean manufacturing.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓											
CO2		✓									✓	
CO3	✓											
CO4			✓									✓
CO5				✓								

MMPESCN	**ADVANCED MANUFACTURING PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To acquaint the students with recent developments in modern casting and welding processes.
- To introduce students to the scientific principles underlying material behaviour during manufacturing processes.
- To make students aware of the necessity to manage manufacturing processes and systems for the best use of material.

UNIT I

Advanced casting processes - plaster mold and ceramic mold casting – vacuum casting – Evaporative pattern casting, ceramic shell investment casting, slush casting, squeeze casting and semisolid metal forming-Rapid solidification for Amorphous alloys.

UNIT II

Advanced welding processes: Basic principle, Process variables, Chief characteristics and applications of the following processes: Laser beam welding, Electron beam welding, Plasma arc welding, Friction stir welding, Explosive welding, Ultrasonic welding and diffusion welding.

UNIT III

Powder metallurgy processes: Methods of Powder production – Blending of metal powders- Compaction of metal powders- Sintering – hot pressing – Isostatic pressing – hot and cold (HIP and CIP), selective laser Sintering – Other shaping processes – Metal Injection moulding, pressureless compaction, ceramic moulds – spray deposition - Finishing of sintered parts.

UNIT IV

Manufacturing processes for plastics: Extrusion, Injection, Blow and rotational moulding of plastics-Thermoforming-Compression moulding – Transfer moulding - Casting– Foam moulding - Processing of reinforced plastics and composite –Moulding – compression, vacuum bag – contact – resin transfer – transfer / injection. Filament winding.

UNIT V

Rapid prototyping and rapid tooling: Introduction – Stereo lithography – Fused deposition moulding – selective laser machining – Laminated object manufacturing – solid base curing – Direct manufacturing and rapid tooling.

TEXT BOOKS

1. Serope Kalpakjian, and Steven R. Schemid, "Manufacturing processes for Engineering Materials", 4th edition, Pearson Education, 2003.
2. Serope Kalpakjian, and Steven R. Schemid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education, 2003

REFERENCES

1. Brahem T. Smith, "Advanced machining", I.F.S., U.K.1989.
2. Amstead, B.H., Ostwald Phylips and Bageman.R.L., "Manufacturing Processes" John Wileys Sons, 1987.
3. Muccic, E.A., "Plastic Processing Technology", Materials park, OHIO, ASM Int.,1994.
4. Jaeger, R.C., "Introduction to microelectronic Fabrication", Addision-Wesley, 1988.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. The student will be able to understand the latest processes in the field of Manufacturing Technology.
2. An understanding of Powder metallurgy processes and Welding processes
3. To gain knowledge on processing of plastic
4. Realize the need and place for rapid prototyping approach.
5. Ability to develop a project on design and product development, considering advanced production technologies.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1			✓	✓								✓
CO2			✓						✓			
CO3			✓		✓				✓		✓	
CO4			✓	✓				✓				
CO5			✓		✓				✓		✓	

MMPESCN	**NON DESTRUCTIVE TESTING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the various aspects of destructive testing and Non-destructive testing

- To introduce the fundamentals of advanced materials testing methods

UNIT I

Liquid penetrant system – Processing cycles –Inspection of surface defects- Generation of Magnetic fields-Magnetic particle inspection equipments – Demagnetization- Applications and limitations.

UNIT II

Production of X-rays – Characteristics rays and white rays- Tube current and voltage – Source of γ ray - Half-life period- Penetrating power – Absorption of x and γ ray – Radiation contrast and film contrast- Exposure charts - penetrameters and sensitivity –Safety.

UNIT III

Eddy current production – Impedance concepts –Inspection of magnetic materials- Inspection of Non magnetic materials –Influences of various parameters-Advantages and limitations.

UNIT IV

Production of ultrasonic waves – Different types of waves-Normal beam inspection – Angle beam inspection-Thickness measurements –Applications.

UNIT V

Principle of acoustic emission- Instrumentation for Non destructive testing- Principles of holography-Applications of holographic techniques Non destructive inspection-Advantages and limitations- Other techniques.

TEXT BOOKS

1. Barry Hull and Vernon John, "Non Destructive Testing", Mac Millan, 1988.

REFERENCES

1. Metals Hand Book, "American Society of Metals", 9thEdition,Volume-11, 1980.
2. Birchand, D., "Non Destructive Testing", Oxford University Press, 1977.
3. Proceedings of the 10th International Acoustic Emission Symposium, Japanese Society for Non Destructive Inspection, Sendai, 1990.
4. Holler, P., "New Procedures in Non Destructive Testing", Springer Verlag, 1983.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. To provide better understanding of the principles of various Non destructive testing methods
2. To impart knowledge on the advantages and disadvantages of the processes
3. To understand the application of acoustic emission testing methods
4. Able to select appropriate NDT method for testing of defects

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓								✓			✓
CO2		✓	✓	✓		✓	✓					
CO3		✓	✓	✓		✓	✓					
CO4	✓								✓		✓	

OPEN ELECTIVE COURSES

MMOESCN	**OPERATIONS RESEARCH**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce students the use of quantitative methods and techniques for effective decisions–making.
- To provide an understanding of the systematic approach to solve decision making problems.
- To enhance the decision-making skills through the application of appropriate models.

UNIT I

Linear programming - graphical method - Simplex method - Big M method- Applications – Problems.

UNIT II

Transportation problems - optimal solutions. Assignment problems - Hungarian algorithm - Traveling salesman problem – applications – Problems.

UNIT III

Waiting line Problems - cost of waiting and cost of providing service - single channel - single stage type of problems - Monte Carlo simulation for queue problems.

Network models - Minimal spanning tree problem, shortest route problem and Maximum flow problem.

UNIT IV

PERT and CPM - basic steps - rules for constructing the network - Fulkerson's rule - time estimates - PERT calculations - probability of meeting the time schedule - time - cost trade off (crashing) - difference between PERT and CPM – applications.

UNIT V

Decision Theory - Decision making under risk condition - expected monetary value criteria - Decision trees - Decision making under uncertain conditions - Minimax, maximin, maximax, Hurwitz and Regret criteria.

TEXT BOOKS

1. Gupta and Hira, “Operations Research”, S. Chand & Co., 1998.
2. Vohra, N.D., “Quantitative Techniques in Management”, Tata McGraw-Hill, 1990.

REFERENCES

1. Sharma, S.D., "Operations Research", Kedarnath Ramnath and Co., Meerut, 1998.
2. Barry Render, Ralph M. Stair Jr., "Quantitative analysis for Management", Pearson New Delhi, 2010.
3. Ravindran, A., Phillips, D.T., and Solberg, J.J., "Operations Research, Principles and Practice", John Wiley and Sons, Singapore, 1987.
4. Taha, "Operations Research", Tata McGraw-Hill, 1998.
5. Bronson, R., "Theory and Problems of Operations Research", Schaum's outline series,1997.

COURSE OUTCOMES

Upon successful completion of the course, the students are able to

1. Formulate and solve linear programming models and s
2. Apply the concept of waiting line to analyze waiting cost and level of service
3. Develop solutions for various assignment problems
4. Apply project management techniques
5. Select appropriate decision making models for the real life problems.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓										✓
CO2		✓	✓									✓
CO3		✓	✓									✓
CO4		✓	✓					✓				
CO5		✓	✓		✓							

MMOESCN	**MACHINE TOOL DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the various drive systems used in machine tools
- To understand the basic design aspects of various of machine tool components and structures

UNIT I & II

Various driving systems for machine tools - Stepper motors - Use of preferred numbers in machine tools - Stepped drives - Graphical representation of speed - structural and ray diagrams - Optimum ray diagram - Ruppert drive - Feed gear boxes - Norton ssdrive - Meander drive. Various stepless regulation systems - principles of self aligning - methods of increasing the range of regulation in modern machine tools

UNIT III

Machine tool guides - types - Design of guide ways - wear adjustment - Anti friction ways - Hydrodynamic and hydro-static slide ways.

UNIT IV

Machine tool beds - types - constructional and design features - Design of column of drilling and milling Machine - Stiffeners and ribs arrangement.

UNIT V

Design of power screws - compensation for backlash - Re circulating ball screw - Spindles - Materials - Construction, spindle supports - Preloading of Bearing Design of spindles - Air bearing and Hydrostatic bearings.

TEXT BOOKS

1. Basu, S.K., and Pal, D.K., "Design of Machine Tools", Oxford and IBH, New Delhi, 1997.
2. Metha, N.K., "Machine tool Design and Numerical Control", Tata McGraw-Hill, New Delhi, 1999.

REFERENCES

1. Sen and Bhattacharya , "Principles of Machine Tools", Volume- II, New Central Book Agency, Calcutta, 1990.
2. Acherkan, "Machine Tool Design", Volume-I to IV, MIR Publishers, Moscow, 1978.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Apply the concept of preferred numbers in machine tools
2. Differentiate the types of drives for machine tools
3. Develop an understanding of the constructional and design features of machine beds, columns
4. Develop an understanding of the constructional and design features of machine guideways
5. Design and develop power screws

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓								✓
CO2		✓	✓									
CO3	✓	✓									✓	
CO4	✓	✓	✓									
CO5		✓	✓									

MMOESCN	**NEURAL NETWORKS AND FUZZY LOGIC**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To learn the concepts to increase machine IQ by overlapping the dynamic system, adaptive control, Statistics with probability and mathematical logic.

UNIT I

Introduction to Fuzzy Logic Principles: Basic concepts of Fuzzy Set theory - Operations of Fuzzy sets - Properties of Fuzzy sets - Crisp relations - Fuzzy relational equations - operations on Fuzzy Relations Fuzzy systems - Propositional Logic - Inference - Predicate Logic - Inference in Predicate Logic - Fuzzy Logic Principles - Fuzzy Quantifiers -

Fuzzy Inference – Fuzzy rule based systems – Fuzzification and Defuzzification – types.

UNIT II

Advanced Fuzzy Logic Applications: Fuzzy Logic Controllers - principles - Review of Control systems theory -Various industrial applications of FLC - Adaptive Fuzzy systems - Fuzzy Decision making Multi objective Decision making - Fuzzy Classification – c Means Clustering -Fuzzy pattern Recognition - Image processing applications - Syntactic Recognition - Fuzzy optimization - Various Fuzzy measures.

UNIT III

Introduction to Artificial Neural Networks: Fundamentals of Neural Networks - Model of an Artificial Neuron - Neural network Architectures – Learning methods - Taxonomy of Neural network Architectures Standard Back propagation Algorithms - Selection of various-parameters - Variations - Applications of Back Propagation Algorithms.

UNIT IV

Other JANN Architectures: Associative Memory - Exponential BAM - Associative Memory for Real Coded Pattern Pairs - Applications Adaptive Resonance Theory - Introduction - ART 1 - ART2 - Applications - Neural Networks based on Competition - Kohenen Self Organizing Maps - Learning vector Quantization - Counter Propagation Networks Industrial Applications.

UNIT V

Recent Advances: Fundamentals of Genetic Algorithms - Genetic Modeling - Hybrid systems - Integration of Fuzzy Logic, Neural Networks and Genetic Algorithms - Non Traditional Optimization Techniques like Ant Colony Optimization, Particle -Swam Optimization and Artificial, Immune Systems - Applications in Design and Manufacturing.

TEXT BOOKS

1. S. Rajasekaran, G.A. Vijayalakshimi, “ Pai Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India Private limited, 2003.

REFERENCES

1. Klir.G, Yuan.B.B, "Fuzzy sets and Fuzzy Logic", Prentice Hall of India Private limited, 1997.
2. Timothy J.Ross,"Fuzzy Logic with Engineering Applications". N1cGraw Hill, 1995.
3. ZuradaJ .M, "Introduction to Artificial of Neural Systems", Jaico Publishing House, 1994.
4. Laurence Fausett, "Fundamentals of Neural Networks", Prentice Hall. 1992.
5. Gen, M. and R.Cheng," Genetic Algorithm and I I Engineering Design", John Wiley, 1997.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Inculcate the knowledge of principles of fuzzy logic
2. Inculcate the knowledge of principles of neural network concepts
3. Have an understanding in the Recent Advances of Non Traditional Optimization Techniques

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓			✓							
CO2	✓	✓			✓						✓	
CO3	✓	✓			✓							✓

MMOESCN	**MAINTENANCE MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To impart a better understanding of the fundamental philosophies of Maintenance Management, and the different techniques that enable the selection of the optimum maintenance strategy. It also discuss the concepts of reliability engineering and spare parts management

UNIT I

Maintenance system: Types of Maintenance - Maintenance strategies and planning – quantitative analysis – Breakdown – time frequency distributions – Breakdown maintenance policy, preventive maintenance policy- Selection of repair Vs preventive maintenance policy – Probability model – expected value model - simple problems. Introduction to TPM – six big losses – pillars of TPM – 5s – Overall Equipment Effectiveness (OEE)

UNIT II

Maintenance facilities planning: Planning of Maintenance Function – Long range planning – Short range planning – Man power allocation - Planning techniques – Planning steps - Optimal number of machines / crew size - Use of waiting line and Simulation model.

UNIT III

Replacement strategies and Policies: Basic concepts of replacement analysis, economic service life, opportunity costs - Replacement analysis using specified time period - probabilistic replacement models – simple problems

UNIT IV

Reliability Engineering: Bath tub curve - Failure data analysis and life testing – Reliability parameters – System reliability with components in series, parallel and mixed configuration – Active, partial and standby redundancy – Availability and Maintainability concepts - Reliability centered maintenance – FTA, FMECA.

UNIT V

Spares management: Spare parts management - Characteristics of spare parts inventory – Approaches for selective inventory control – VED/ABC analysis – Models for breakdown spares, capital spares, insurance spares and rotable spares – simple problems.

REFERENCES

1. Chary S.N., "Production and Operations Management" Theory and Problems, TMH, New Delhi, 1990
2. Monks J.G., "Operation Management" Theory & Problems, McGraw Hill, 1987
3. Srinath L.S., "Concepts in Reliability Engineering", East west press Ltd. 1991
4. Bikas Bhadury and S.K. Basu, Terrotechnology: Reliability Engineering and Maintenance Management, Asian Books Pvt., Ltd., New Delhi, 2003
5. Seiichi Nakeiima, "Introduction to Total Productive Maintenance", Productivity Press (India) Pvt Ltd., Madras, 1988
6. Mishra R.C., Pathak K., "Maintenance and Engineering Management", Prentice hall India Private Limited, New Delhi, 2002

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Develop a maintenance plan for a technical system
2. Have a working knowledge of the techniques of reliability engineering
3. Apply learned concepts to improve the maintenance, the maintainability, hazard risk and the safety of the plant
4. Apply problem solving models to maintenance
5. Analyze different failure of a component/equipment

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓			✓							
CO2	✓	✓			✓							
CO3	✓	✓			✓						✓	
CO4							✓					
CO5			✓			✓						✓

MMOESCN	**ENGINEERING ECONOMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the student to the cost implications of the various decisions that may have to be made in a manufacturing environment.

UNIT I

Basic concepts, terms, demand – supply relationship, Role of engineering economics in decision making, Interest calculation (simple & compound), cash (IN/OUT) flows,.

UNIT II

Principle of money – Factors and their uses – single payment factors, uniform series present worth factor - capital recovery factor, sinking fund factor present worth, future worth and equivalent uniform annual worth calculation.

UNIT III

Application of money – time relationships: present worth, capitalized cost evaluation, equivalent uniform annual worth calculation, rate of return components for single projects, rate of return evaluation for multiple alternatives.Minimum attractive rate of return.

UNIT IV

Replacement strategies and Policies: Basic concepts of replacement analysis, economic service life, opportunity costs - cash flow approaches to replacement analysis - Replacement analysis using specified study period - probabilistic replacement models.

UNIT V

Cost volume profit relationship – relevant costs in decision making – profit management analysis - aluation, alternative selection by cost-benefit break-even analysis and its application, payback period. Depreciation methods: straight line, declining balance, sinking fund - Depletion models – cost depletion, percentage depletion methods.

TEXT BOOKS

1. Leland Blank, T., and Anthony J. Tarquin, "Engineering Economy", McGraw-Hill, Singapore, 4th Edition 1998.
2. Riggs, J.L., Bedworth, J.A., and Randhava, S.U., "Engineering Economics", McGarw Hill,1998.

REFERENCES

1. Degarmo, E.P., Sullaivan, W.G., and Bontadelli, J.A., "Engineering Economics", Macmillan Pub. Co., New York, 1993.
2. Stenier, H.M., "Engineering Economics Principle", McGraw-Hill, New York, 1992.
3. Thuesen, G.J., and Fabrycky, W.J., "Engineering Economics", Prentice Hall International, New Jersey, 1993.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the basic terms of economics
2. Understand the principle of money and depreciation
3. Apply present worth criterion of money
4. Develop and compare different replacement policies
5. Recognize the cost volume profit relationship

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓						✓			
CO2		✓		✓	✓							
CO3		✓	✓									
CO4	✓		✓	✓	✓							
CO5	✓		✓	✓								

MMOESCN	**SENSORS AND CONTROL SYSTEMS IN MANUFACTURING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To equip the students with concepts of sensor performance, product monitoring and control applications in robotics.
- To acquaint the student with the elements of CIM, FMS and the integration of manufacturing functions.

- To provide students with a sound understanding of the use of advance instrumentation and sensing methods.
- Understand the various components of sensor network architecture, networks in manufacturing and PLC.
- To provide an exposure to current trends in areas related to fiber optics in sensor and biomedical technology.

UNIT I

Sensor Fundamental , Classification and Types of Sensors, Desirable Sensor Attributes, Sensor Performance and Power dissipation -a trade off, Self-Checking and Self Compensating Sensors- Sensor for Work Pieces and Product Monitoring.

UNIT II

Identification of Manufactured Components, Digital Encoders, Opto Electronic Color Sensors - Principles, Properties, Features and Control Applications in Robotics.

UNIT III

Design of CIM, Decision Support System for CIM, Analysis and Design of CIM, and Development of CIM Strategy with Sensor and Control. FMS- Robot Control with Vision Sensors, Multi Sensor Controlled Robots, Measurement of Robot Density, Robot Programming.

UNIT IV

Sensor Network Architecture , Sensor Tracking, Sensors to Detect Machinery Faults, Networks in Manufacturing, Computer Communications- Interface of Sensors With Single Board Computer for PLC, and Numerical Control. Networking with Electro Optic Link using Fiber Sensors.

UNIT V

Fiber Optics in Sensor and Control System.- Fibre Optics Parameters, Configurations, Photo Electric Sensor for Long Distance, Sensor Alignment Techniques, Sensors for Biomedical Technology.

TEXT BOOKS

1. Sabrie Soloman, "Sensors and Control systems in manufacturing", McGraw-Hill Publications, 2th edition 2010.

REFERENCES

1. Tonshoff, H.K., and Inasaki, I., "Sensor Applications, vol. 1 sensors in Manufacturing", Wileyvch Publications 2001.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Learn the basics of sensor requirement in product monitoring.
2. Provide an introduction to condition monitoring procedures and system integration
3. Know about Identification of manufactured Components and applications in Robotics.
4. Provide understanding of the use of advanced instrumentation and sensing methods.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓							
CO2				✓					✓	✓	✓	
CO3		✓	✓					✓				✓
CO4		✓	✓					✓				✓

MMOESCN	**SURFACE ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

This course will enable the student

- To familiarize the basic concepts of Surface Engineering and Tribology
- To introduce the various aspects of wear, its mechanism and control.
- To introduce the fundamentals of various surface modification processes.
- To introduce the concepts of thick film and thin film coatings.

UNIT I

Mechanisms of wear and metal cleaning: Basic mechanisms of wear - abrasive, adhesive wear, contact fatigue – fretting corrosion – Testing of wear resistance – Practical diagnosis of wear – General cleaning process for ferrous and non ferrous alloys – Selection of cleaning processes – alkaline cleaning, emulsion cleaning abrasive bath cleaning – polishing, buffing and hot peering.

UNIT II

Thermal spraying processes and Electro deposited coatings: Thermal spraying-materials, characteristics of thermal spray process – Designing for thermally sprayed coatings – coating production – spray fused coatings – Principles of electroplating – technology and control – electroplating – Technology and control – electroplating systems – properties and applications of electro deposits - non - aqueous and electroless deposition.

UNIT III

Hot dip coating and diffusion coatings: Principles – surface preparation-batch coating and continuous coating – properties and applications principle of cementation – cladding, vacuum deposition – sprayed metal coating – structure of diffusion coatings – chemical vapor deposition – physical vapor deposition

UNIT IV

Non metallic coatings and conversion coatings: Plating coating – lacquers – rubbers and elastomers – Vitreous enamels – anodizing, Chromating, Phosphating

UNIT V

Weld surfacing: Hard facing, overlaying – Laser cladding – Explosive cladding – Roll bonding - Testing and inspection of coatings: Thickness and porosity measurement – selection of coatings

TEXT BOOKS

1. Stan Grainger, “Engineering Coatings – Design and Applications”, Jaico, 1994.

2. Parthasarathy, N.V., "Electroplating Hand Book", Prentice Hall, 1992.

REFERENCES

1. Gale, D.R., "Principles of Metal Surface Treatment & Protection", Pergamon, 1990.
2. Niku-Lavi, "Advances in Surface Treatments", Pergamon, 1990.
3. "Metals Handbook on Surface Engineering", 8th Edition, ASM, 1994.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Provide engineering knowledge on the importance of methods of Surface Engineering
2. Understand the various aspects of thick film coatings and thin film coatings for manufacturing products
3. Provide better knowledge on the concepts on surface characterization.
4. Understand the usage of implementation on testing of coatings and inspection of surface on surface engineering.

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		✓										✓
CO2					✓							
CO3				✓						✓		
CO4				✓								

MMOESCN	**PRECISION ENGINEERING AND NANO-TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the concept of precision engineering and manufacturing methods
- To introduce the concept of nano technology and scanning instrumentation
- To make an understanding of MEMS

UNIT I

Introduction: Definition - Introduction to Precision Engineering and Manufacturing- Accuracy, Repeatability - Principles of Measurement - Precision Flexure Design. Precision Optical Manufacturing - Micro - Optics - Precision Machine Design - Micro - Sensors: Design - fabrication - Testing and packaging.

UNIT II

Principles: Principles and Application of precision Engineering to the design of Instruments and Manufacturing Equipment. Principles of Metrology - Accuracy, Resolution. Sensors, Actuators. Bearings flexures for Precision Motion Generation.

UNIT III

Precision Manufacturing: Manufacturing Methods in Precision Engineering - Joining Technologies - Finishing processes - Special Casting techniques - Etching techniques -

Coatings with metals & Inorganic Materials - Optical Production Methods - Vacuum Deposition MEMS & Micro Machining.

UNIT IV

Nano Technology & Instrumentation: Nano Technology - Introduction to Scanning Probe Microscopy (SPM) - contact mode, Tapping Mode, Scanning Tunneling Mode(STM), Atomic Force Microscope (AFM), Advanced SPM - Electrostatic Force Mode (EFM)- Magnetic Force Mode(MFM)- Scanning Capacitance Mode(SCM), Nanoidentation - High Resolution, Drexlerian Nano Technology. Introduction to biological Applications, Quantum Effects & Futures, Quantum Dots, Quantum Computing

UNIT V

Smart structures, Materials and Micro Actuators: Smart structures – smart sensors – micro valves – MEMS - micro motors - micro pumps - micro dynamometer - micro machines - structures assembly - cooling channels - micro optics - micro nozzIes.

TEXT BOOKS

1. Nakazawa H. "Principles of Precision Engineering", Oxford University press, 1994.
2. Mark Ratner and Daniel Ratner, "Nano Technology", Pearson Education, Delhi 2003.
3. Precision engineering in Manufacturing, Murthy.R.L. New Age international Pvt. Limited.

REFERENCES

1. Hand book of Surface and Nano Technology, D.J.White House.
2. Institute of Physics Publishing, Bristol and Philadelphia, Bristol. BSI 6BE U.K.
3. The Science and Engineering of Micro electronic Fabrication, Stephen A. Campbell, Oxford University Press, 1996.
4. Understanding Smart Sensors, Randy Frank, Artech. House, Boston, 1996.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Learn the concept of precision engineering and manufacturing methods
2. Learn the concept of nano technology and scanning instrumentation
3. Expose to the principle of MEMS

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓						✓			✓		
CO2	✓			✓								
CO3					✓			✓				✓
CO4		✓				✓						

MMOESCN	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To impart an in-depth knowledge on composite materials and types
- To make an understanding of the production processing and the structural development in composite materials.

UNIT I

Introduction: Fundamentals of composites – need for composites – Enhancement of properties – classification of composites - Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) Reinforcement - Particle reinforced composites, Fibre reinforced composites, Applications of various types of composites.

UNIT II

Classification of Polymers - properties and applications of selective engineering polymers - Polymer Matrix Composites: Polymer matrix resins - Thermosetting resins, thermoplastic resins - Reinforcement fibres - Rovings - Woven fabrics - Non Woven random mats - various types of fibres. PMC processes - Hand layup processes - Spray layup processes - Compression moulding - Reinforced reaction injection moulding - Resin transfer moulding - Pultrusion - Filament winding - Injection moulding. Fibre reinforced plastics (FRP), (Glass fibre reinforced plastics (GRP)).

UNIT III

Metal Matrix Composites: Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC. Limitations of MMC, Metal Matrix, Reinforcements particles - fibres. Effect of reinforcement - Volume fraction - Rule of mixtures, Processing of MMC - Powder metallurgy process - diffusion bonding - stir casting, squeeze casting.

UNIT IV

Ceramics Matrix Composites: Engineering ceramic materials - properties - advantages limitations - Monolithic ceramics - Need for CMC Ceramic matrix - Various types of Ceramic Matrix composites - oxide ceramics - non oxide ceramics aluminium oxide - silicon nitride - reinforcements particles - fibres - whiskers. Sintering - Hot pressing Cold isostatic pressing (piping) - Hot isostatic pressing. (HIPing)

UNIT V

Advances Composites: Carbon/carbon composites - Advantages of carbon matrix - limitations of carbon matrix Carbon fibre - chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace industrial applications.

REFERENCES

1. Composite materials, Engineering and Science, Mathews .F.L. and Rawings .R.D., Chapman
2. Composite materials, Chawla K.K., SpringerVerlag, 1987
3. Engineering Materials, Kenneth G.Budinski, Prentice Pvt. Ltd., 41th Indian Reprint, 2002
4. Introduction to Metal Matrix Composites, T.W.Clyne and P.J. Withers, Cambridge University Press, 1993

5. Fundamentals of Composite Manufacturing, B. Strong, SME, 1989
6. Composite materials, S.C. Sharma, Narosa Publications, 2000
7. "Short Term Course on Advances in Composite Materials", Composite Technology Centre, Department of Metallurgy, lIT - Madras, December 2001
8. Hand Book of Plastic processing, Brydson,
9. FRP Technology (Fibre Reinforced Resin System), Weatherhead, R.G Applied Science Publishers Limited, London, 1990

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Obtain knowledge on classification of composite materials used in the modern world
2. Obtain knowledge on different types of production technique of composite materials
3. To understand the basics of polymer matrix composites
4. Gain knowledge on the processing methods of metal matrix composites and ceramic matrix composites
5. Acquire knowledge on production of light weight composites that are used in aerospace industries

Mapping of Course Outcomes with Programme Outcomes												
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓						✓	
CO2			✓				✓					
CO3	✓				✓				✓	✓		✓
CO4	✓				✓		✓		✓	✓		✓
CO5	✓		✓		✓				✓	✓		✓

MMOESCN	**SUPPLY CHAIN MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- Discuss the fundamental concepts of supply chain management;
- impart the knowledge on how to align the management of a supply chain with corporate goals and strategies.
- Expose the issues in international supply chain management

UNIT I

Introduction to Supply Chain Management- Definition- Decision phases in supply chain, Process Vs Push pull view of supply chain-The development chain - Design the right sc- functional Vs innovative products- product life cycle and SC design – clock speed.

UNIT II

Supply chain (SC) performance and evaluation: Order Winning to Order fulfillment-SCOR Model – Balance Score card model. SC Strategies: Efficient Vs Responsive strategy-Agile Vs Lean supply chain, postponement strategy- push pull strategy.

UNIT III

Value of Information- Bullwhip effect- information and supply chain technology- Supply chain integration- Concepts of MTO, MTS, ETO and ATO -demand driven strategies- impact of internet on SCM-

UNIT IV

Supply network – factors influencing supply chain network design - distribution strategies VAT material flow analysis. Strategic alliances – Make or buy decision – Framework for strategic alliance – outsourcing - Krajalic matrix - core competency – 3PL-4PL – Effect of Demand and supply uncertainty- cross docking- - risk pooling- Square root law -centralized vs decentralized system

UNIT V

Global SC - International Issues in SCM- Introduction- risks and advantages- design for logistics- supplies integration into to new product-development- mass customization- Issues in customer value – Information technology for SCM- Goals - standardization- infrastructure- DSS for supply chain management.

REFERENCES

1. Designing and managing the Supply Chain, Simchi - Levi Davi, Kaminsky Philip and Simchi-Levi Edith, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2003
2. Supply chain management, 2nd edition, Sunil Chopra and Peter Meindl, Pearson Education, New Delhi, 2003.
3. Supply Chain Management: Text and Cases, Janat Shah, Pearson Education India, 2009.
4. Supply Chain Management, Robert B Hand Field and Ernest Nichols, Prentice Hall, New Jersey, 1999.
5. Supply chain management: concepts, techniques and practices, Ling Li, world scientific press, 2011
6. Supply chain management (Theories & practices), R Mohanty andS G Deshmukh, Ist edition, Biztantra innovation in management, 2005

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the roles of supply chain among various business functions and their roles in the organizations' strategic planning and gaining competitive advantage
2. Able to actively employ supply chain management methodologies
3. Able to apply supply chain techniques in both manufacturing and service industries
4. Analyze the principles, concepts and challenges for developing sourcing, manufacturing and distribution strategies in a global market.
5. Describe the role of information technology to improve the performance of the supply chain

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓			✓							✓
CO2	✓	✓			✓							
CO3	✓	✓			✓						✓	
CO4							✓					
CO5			✓			✓						✓

HONOURS ELECTIVE COURSES

MMHESCN	MECHANICAL BEHAVIOUR OF MATERIALS	L	T	P	C
		3	0	0	4

COURSE OBJECTIVES

- To impart a sound understanding of the tensile, hardness and toughness behaviour of materials.
- To understand the factors affecting the fatigue and fracture behaviour of materials.
- To study the time dependant mechanical behaviour of materials.

UNIT I

Tensile behaviour: Engineering stress-strain curve: Derivation of tensile strength, yield strength, ductility, modulus of elasticity, resilience and toughness from stress strain curves, comparison of stress-strain curves for different materials - True Stress - Strain Curve: true stress at maximum load, true fracture strain, true uniform strain, Necking strain - necking Criteria - Effect of strain rate, temperature and testing machine on flow properties - Notch tensile test - Tensile properties of steel

UNIT II

Hardness & Toughness behaviour: Hardness Measurements: Brinnell hardness, Meyer's hardness, Vickers hardness, Rockwell hardness and Microhardness - Relationship between hardness and the flow curve - Hardness at elevated temperatures - Toughness measurements: Charpy, Izod and Instrumented Charpy - Transition Temprature Curves: significance, various criteria, metallurgical factors affecting the curves, Drop weight test, explosion crack starter test, Dynamic tear test and Robertson crack arrest test - Fracture Analysis Diagram.

UNIT III

Fatigue behaviour: Introduction: Stress cycles, S-N curves Goodman diagram, Soderberg diagram, Gerbar diagram - Cyclics stress strain curve - Low cyle fatigue - Strain life Equation - Fatigue mechanisms - High cycle fatigue - Effect of following paramenters on Fatigue: mean stress, stress concentration, specimen size, surface roughness, residual stress, microstructure and temperature. Fatigue crack propagation.

UNIT IV

Fracture behaviour: Types of fracture in metals: ductile and brittle fracture - Theoretical cohesive strength of metals - Griffith theory - Metallographic aspects of fracture - Fractography - Notch effect - Concept of fracture curve - Fracture mechanics: strain energy release rate, stress intensity factor, crack deformation modes, fracture toughness testing, plastic zone size correction, crack opening displacement, J-integral and R-curve.

UNIT V

Time dependant mechanical behaviour: Creep curve - Stress rupture Test - Structural changes during creep - Mechanisms of creep deformation - Deformation mechanisms maps - Activation energy for steady state creep - Fracture at elevated temperature - Introduction to high temperature alloys - Predication of long time properties - Creep under combined stresses - Creep- Fatigue Interaction.

REFERENCES

1. George E.Dieter, Mechanical Metallurgy, Tata McGraw – Hill Education Pvt.Ltd, 3rd Edition. New Delhi, 2014.
2. Hertzberg R.W., Richard W. Hertzberg , Richard P. Vinci , Jason L. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, Inc., 5th Revised Edition, New York, 2012.
3. Thomas Courtney. H, Mechanical Behavoiur of Materials, McGraw Hill 2nd Edition, 2005.
4. M.A.Meyers and K K.Chawla, Mechanical Behavior of Materials, Cambridge University Press, 2009
5. H. Kuhn and D. Medlin , Metals Handbook, Mechanical Testing, Vol.8, American Society for Metals, Metals Park, Ohio, 2000
6. Broek.D, Elementary Engineering Fracture Mechanics, 4th Edition.,Martinus Nijhoff Publishing , The Hague, 2008

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the mechanical behaviour of metals;
2. Protect the metals from fatigue damage.
3. Understand the environmental factors affecting the mechanical behaviour of materials
4. Evaluate the high temperature properties of metals.
5. Design the metals for specific applications;

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓			✓					✓		
CO2	✓	✓			✓							
CO3	✓	✓			✓							✓
CO4							✓					
CO5			✓			✓						

MMHESCN	**MODERN MANUFACTURING STRATEGIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To provide knowledge and understanding of the modern manufacturing strategies
- Present a broad conceptual framework for the management of the operations function across the supply chain.

UNIT I

Total Productive Maintenance (TPM) - Six big losses – TPM implementation – TPM and TQC.

UNIT II

Supply Chain Management (SCM)-Basic concepts – Supplier selection – Analytic Hierarchy Process (AHP) – Customer-supplier relationship – JIT and SCM - ERP Vs SCM-Logistics management.

UNIT III

Just-in-time (JIT)- JIT philosophy – Objectives – Sources of waste – Waste reduction – Value added focus – push system-pull system – push vs pull system – kanban – JIT implementation

UNIT IV

Business Process Re-engineering (BPR)- Basic concepts – TQM and BPR – Traditional IE and BPR- Benchmarking-Types of benchmarking-overview and approaches to Concurrent Engineering - Agile and Lean Manufacturing- Small lot Production – Setup time reduction – SMED methodology.

UNIT V

Other Management Techniques - Technology Management – Strategic Management - Decision Support Systems (DSS) – Manufacturing flexibility - Enterprise wide information system (EWIS) – Enterprise resource planning (ERP) – selection of ERP - Product development – SWOT analysis – Value stream mapping – Customer relationship management – Re-Manufacturing.

TEXT BOOKS

1. Industrial Engineering and Management, Ravishankar, Galgotia Publications pvt. Ltd., New Delhi. 2002

REFERENCES

1. Advanced Operations Management, Mohanty R.P., and Deshmukh S.G., Pearson Education (Singapore) Pvt. Ltd., New Delhi, India.2003.
2. Competitive Manufacturing Management, Nicholas J.M., TMH, New Delhi. 2001.
3. Introduction to Total Productive Maintenance, Seiichi Nakeiima, Productivity Press (India) Pvt Ltd., Madras, 1988.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Recognize and apply the concept of Total Productive Maintenance
2. Understand the roles of supply chain among various business functions and their roles in the organizations' strategic planning and gaining competitive advantage
3. Appreciate the effect of waste reduction
4. Know and apply Business Process Re-engineering techniques
5. Know Technology Management and Strategic Management concepts

Mapping with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		✓	✓	✓								
CO2			✓	✓						✓		
CO3			✓	✓							✓	
CO4	✓	✓	✓									
CO5			✓	✓			✓					

MMHESCN	ROBOTICS AND AUTOMATIONS	L	T	P	C
		3	0	0	4

COURSE OBJECTIVES

- To know about the basic concepts in industrial automation
- Be exposed to pneumatic, electric, hydraulic and electronic systems in automation of mechanical operations
- Describe in detail how industrial robot systems are used, structured and operate,
- Identify fundamental issues within sustainable industrial development from an automation perspective and be able to exemplify the consequences of these,
- Implement and present a basic automation task with an industrial robot, including pilot study, online and offline programming and evaluation of the results, based on a given specification.

UNIT I

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation

Transfer Lines And Automated Assembly: General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly - design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, modular fixturing, Flow line balancing

UNIT II

Design of Mechatronic Systems: Stages in design, traditional and mechatronic design, possible design solutions. Case studies-pick and place robot

UNIT III

Programmable Automation: Special design features of CNC systems and features for lathes and machining centers. Drive system for CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems

Design for High Speed Automatic Assembly: Introduction, Design of parts for high speed feeding and orienting, high speed automatic insertion. Analysis of an assembly. General rules for product design for automation

UNIT IV

Basic Concepts: Automation and Robotics - Brief history of Robotic technology - Robot classifications and specifications - Various manipulators: End effectors and Tools - Sensors - work cell - Programming methods – Robot vision system

UNIT V

Types of Robots: Application of robots in various fields: Non-conventional industrial robots, Service industry, Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications. Humanoid robots: Wheeled and legged

TEXT BOOKS

1. Mikell P Groover, Automation Production Systems and Computer Integrated Manufacturing, Pearson Education, New Delhi, 2001
2. Bolton W, Mechatronics, Pearson Education, 1999
3. Mikell P Groover, Industrial Robots – Technology, Programming and Applications, McGraw Hill, New York, USA. 2000

COURSE OUTCOMES

1. Gain fundamental concepts in automation
2. Knowledge of industrial automation by transfer lines and automated assembly lines
3. Understand advancement in hydraulics and pneumatics systems
4. To understand the importance of robots in automation
5. Use Robots for different applications

Mapping of Course Outcomes with Programme Outcomes												
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		✓				✓				✓		✓
CO2	✓			✓								✓
CO3		✓				✓	✓			✓		✓
CO4		✓				✓	✓					✓
CO5		✓				✓	✓					✓

MMHESCN	**PLANT LAYOUT AND MATERIAL HANDLING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- Introduce the concepts of layout planning and the various algorithms used
- Introduce the design of material handling systems, mechanized assembly, hoppers and feeders and transfer systems.

UNIT I

Plant Layout: Need for Layout Planning – Layout Objectives and Determinants. Process Layout: Operation Sequence Analysis – Load-Distance Analysis – Travel Chart – Muthur's systematic layout planning – Pair-wise Exchange Method–Simple Problems. Product Layout: Line Balancing– Largest Candidate Rule – Kilbridge & Wester's Method – Ranked Positional Weight Method – COMSOAL.

UNIT II

Apples plant layout procedure – Reed's plant layout procedure - Computer Aided Plant Layout Planning: CORELAP, PLANET, MAT, ALDAP, CRAFT - Plant Layout Algorithms: Modified spanning tree algorithm – Graph based method – BLOCPLAN Algorithm

UNIT III

Facilities planning - Introduction to models for single row machine layout problem - multi-row layout problem and quadratic assignment model - introduction to algorithms for the multi-row layout problems.

UNIT IV

Material Handling Functions - Principles - Types of Material Handling Systems. Analysis of Material Handling Equipment. Economic Analysis of Material Handling Equipments: Breakeven Analysis – Equipment Operating Cost Per Unit Distance – Work Volume Analysis – Illustrative Problems. Productivity / Indicator Ratios. Packaging: Functions – Materials – Palletizing – Packaging Equipments.

UNIT V

Mechanized Assembly: Principles and Operating characteristics of Part Feeders such as Vibratory Bowl Feeder, Reciprocating Tube Hopper, Centrifugal Hopper Feeder and Center Board hopper feeder – Orientation of Parts – In-bowl and Out-of-bowl tooling – Different Types of Escapements Transfer Systems and Indexing Mechanisms.

REFERENCES

1. Material Handling, John R. Immer, McGraw Hill Book Coy, 1953
2. Facility Layout and Location: An Analytical Approach, Francis R. L., McGinnis L. F., & White J. A., PHI, 1999
3. Manufacturing Facilities: Location, Planning & Design. Sule D. R., PWS Publishing Co., Boston, 2nd Edition, 1994
4. Facilities Design, Sunderesh Heragu, PWS Publishing Co., Boston, 1997
5. Materials Management & Materials Handling, Sharma S. C., Khanna Publishers, New Delhi
6. Production and Operations Management – Principles and Techniques, Ray Wild, ELBS
7. Analysis and control of production systems, 2nd edition, Elsayed A., and Thomas O. Bouchar Prentice Hall, NJ, 1994
8. Theory and Problems in Operation and Production Management, Chary S. N., Tata-McGraw Hill, 1994
9. Mechanised Assembly, Boothroyd & Redford
10. Automation, Production Systems and Computer-Integrated Manufacturing, Groover M.P., PHI, New Delhi, 2002
11. Facilities Planning, III Edition, Tompkins, White, Bozer, Tanchoco, John Wilery & Sons Pvt.Ltd, Singapore, 2003

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the different layout planning techniques
2. Apply layout planning techniques for solving layout problems
3. Carryout economics analysis of material handling equipments

4. To understand the concepts of mechanized assembly

Mapping of Course Outcomes with Programme Outcomes												
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		✓				✓					✓	
CO2	✓			✓								✓
CO3							✓					
CO4	✓	✓	✓		✓	✓						✓

MINOR ENGINEERING COURSES

MMMESCN	**MACHINE TOOLS AND METAL CUTTING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**4**

COURSE OBJECTIVES

- To impart an understating of the principle of metal cutting
- To provide knowledge of various cutting tool materials
- To provide an overview of various machine tools and operations performed
- To focus on the principle of Numerical control of machine tools

UNIT I

Fundamentals of Metal Cutting: Mechanics of chip formation – Types of chips – Shear Zone – Orthogonal Cutting – Shear angles and its relevance – Cutting forces and Power – Merchant's Circle – Numerical examples

UNIT II

Cutting Tool Materials: Requirements – Types Tool wear and tool life: Types of tool Wear – Tool life equations – Numerical examples – Machinability – Cutting fluids – Functions – Properties – Types.

UNIT III

Machine Tools: Classifications – Centre Lathe – Constructional features – Operations performed. Special purpose Lathes: Capstan and Turret Lathes – Automatic Lathes – Tooling design for Automatic lathes.

UNIT IV

Reciprocating Machine tools: Shaper – Planer – Slotter – Constructional features – Operations performed. Milling Machines – Types – Operations performed – Types of cutters. Hole making operations: Drilling – Reaming Boring – Tapping – Other Machine tools: Sawing – Broaching – Gear Cutting.

UNIT V

Grinding – Types of grinding machines – Grindery Wheel – Designation and Selection other Abrasive machining processing – Hoping – Lapping – Surface finishing – Polishing and buffing – Abrasive belt grindery – Barrel tumbling – Barrel rolling – Burnishing

Numerical control of machine tools – Principle – Types of control System – NC tooling – Part Programming fundamentals Manual and Computer aided part programing (CAP) (only concepts)

TEXT BOOKS

1. Suresh Dalela, "Manufacturing Science & Technology", Vol. I & II, Umesh Publications, 1997.
2. Radhakrishnan, P., "Computer Numerical control of Machine Tools", New central Book Agency, 2002.

REFERENCES

1. Kalpakjian, S., "Manufacturing Engineering & Technology", 3rd Edition, Addition Wesley Inc. 1997.
2. Hajra Choudhry, S.K., "Elements of Workshop Technology", Media Promoters & Publications Pvt. Ltd, 1994.
3. Krar, S.F., and Check, A.F., "Technology of Machine Tools", Tata McGraw-Hill, New Delhi, 1998.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the principle of metal cutting
2. Gain knowledge of various cutting tool materials
3. Gain knowledge above the various machine tools and operations performed
4. Differentiate single point and multi point cutting tools and machines.
5. Gain and apply the knowledge of NC machines and programming

Mapping of Course Outcomes with Programme Outcomes												
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓									
CO2	✓		✓	✓								
CO3	✓		✓	✓			✓		✓			
CO4	✓						✓					
CO5	✓		✓	✓			✓					

MMMESCN	**METAL CASTING, FORMING AND JOINING PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**4**

COURSE OBJECTIVES

- To introduce the principle of metal casting process and various process elements
- To provide an understanding of various metal forming processes
- To give a focus on the various sheet metal forming operations
- To give broad idea on the various metal joining processes

UNIT I

Basic Terminologies – Patterns – Types – Materials, allowances – Cores – Types – Moulding materials: Sand compositions – Indian sands – Other sands – Properties – Sand mould making, Elements of gating system.

UNIT II

Design of gates and risers – simple problems. Melting practice: Cupola – other furnaces – Cleaning of castings and casting defects – causes. Special casting Process: Shell moulding – Investment casting – Permanent mould casting – Die casting – Centrifugal casting – Continuous casting.

UNIT III

Classification – Hot and Cold working. Rolling load – Defects and causes. Forging – Hand forging operations – Press forging – Forging defects – Drop forging and upset forging. Extrusion: Principle – Formand and Backward – Hot and Cold extrusion – Tube and rod extrusion – Wire drawing – Seamless tubes extrusion.

UNIT IV

Sheet metal forming: Drawing – Redrawing – Stretch forming – Flanging – Spinning – limiting draw ratios – (Bending – Springback) Embossing.
Metal Joining process: Classifications – Gas Welding – Principle – Oxy acetylene – Oxy hydrogen – Gas Cutting.

UNIT V

Electric Arc Welding: Principle – Arc Welding equipments – Electrodes – Manual metal arc welding – Carbon Arc welding – Tungsten Inert gas welding – Gas Metal Arc welding – Submerged arc welding – Atomic hydrogen welding – Solid state welding process.

TEXT BOOKS

1. Parmar, R.S., "Welding Processes and Technology", Khanna Publishers, New Delhi, 2007.
2. Rowe, G.W., "An Introduction to the Principles of Metal Working", Edward Arnold Publication.
3. Campbell, "Casting and Forming Process", McGraw-Hill, 1997.

REFERENCES

1. Nadkarni, S.V., "Modern Arc Welding Technology", Oxford & IBH Publishing Co.Pvt.Ltd, NewDelhi, 1996.
2. Khanna, O.P., "Welding Technology" Dhanpat Rai & Sons Publishers, New Delhi, 1993.
3. George E. Dieter "Mechanical Metallurgy", McGraw-Hill International Edition, Newyork, 1998
4. Robert H. Wagoner and Jean Loup Chenot., "Fundamentals of Metal Forming", John Wiley & Sons Inc., New York, 1992.
5. Heine, R.W., Rosenthal, P.C., & Loper, C.R., "Principles of Metal Casting", Tata McGraw-Hill, 1997.
6. Jain, P.L., "Principles of Foundry Technology", Tata McGraw-Hill, 1997.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Recognize different forming process to manufacture near net- shape product
2. Understand the basic features and terminologies in casting process, gating, reserving system and their design aspects, the basics in solidification or the casting formation.
3. Study the types of defects occurred in casting and provide remedial solutions.

4. Distinguish between fusion welding processes and solid state welding processes;
5. Inspect welding defects using Non-destructive testing methods;

Mapping of Course Outcomes with Programme Outcomes												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓							✓			
CO2	✓	✓	✓									
CO3	✓		✓						✓			
CO4	✓	✓										
CO5	✓		✓									