Vel Tech Multi Tech

Dr.Rangarajan Dr.Sagunthala Engineering College

An Autonomous Institution

Department of Mechanical Engineering

B.E Mechanical Engineering

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI - REGULATIONS 2019

THE VISION
To become a centre of eminence in educating students to become triumphant mechanical engineers.
THE MISSION
* To endue the students with the fundamentals of mechanical engineering with a passion for life-long learning of industry practices
* To propagate life-long learning.
* To impart the right proportion of knowledge, attitudes and ethics in students to enable them take up positions of responsibility in the society and make significant contributions.

PEO	PROGRAMME EDUCATIONAL OBJECTIVES
PEO1	Graduates will apply their knowledge and skills to solve the problems in the field of Mechanical Engineering occurring in industries and transportation.
PEO2	Graduates of the programme will find employment as Mechanical engineers in engineering and business or will be admitted for higher studies.
PEO3	Graduates of the programme will solve problem with professionalism.

PO's	PROGRAMME OUTCOMES
PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Lifelong learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PSO's	PROGRAM SPECIFIC OUTCOMES
PSO1	Ability to understand the principles and working of machines.
PSO2	Ability to understand the structural development methodologies of machines & Possess knowledge of design process.
PSO 3	Ability to use knowledge in various domains to identify research gaps & to provide solution to new ideas and innovations related to Mechanical Engineering.

SEMESTER – I

Sl.No	Course Code	Name of the Course	Category	No. of Periods / Week			Credits
				L	T	P	
THEORY							
1	191MA101	Engineering Mathematics I	BS	2	2	0	3
2	191PH101	Engineering Physics	BS	3	0	0	3
3	191CH101	Engineering Chemistry	BS	3	0	0	3
4	191HS101	English for Engineering Students	HSS	3	0	0	3
5	191ME111	Basic Civil and Mechanical Engineering	ES	3	0	0	3
6	191EE111	Basic Electrical and Electronics Engineering	ES	3	0	0	3
PRACTICAL							
1	191PH10A	Physics Laboratory	BS	0	0	2	1
2	191CH10A	Chemistry laboratory	BS	0	0	2	1
Total				**17**	**2**	**4**	**20**

SEMESTER – II

Sl. No	Course Code	Name of the Course	Category	No. of Periods / Week			Credits
				L	T	P	
THEORY							
1	191MA201	Engineering Mathematics II	BS	2	2	0	3
2	191PH204	Materials Science for Mechanical Engineering	BS	3	0	0	3
3	191HS201	Environmental Science and Engineering	HSS	3	0	0	3
4	191ME211	Engineering Graphics	ES	2	2	0	3
5	191ME212	Engineering Mechanics	ES	2	2	0	3
6	191ME221	Manufacturing Technology I	PC	3	0	0	3
PRACTICAL							
1	191ME21A	Engineering Practices Laboratory	ES	0	0	4	2
Total				**15**	**6**	**4**	**20**

SEMESTER – III

Sl. No	Course Code	Name of the Course	Category	No. of Periods / Week			Credits
				L	T	P	
THEORY							
1	191MA305	Transforms and Partial Differential Equations	BS	2	2	0	3
2	191ME311	Fluid Mechanics and Machinery	ES	2	2	0	3
3	191EE311	Electrical Drives and Controls	ES	3	0	0	3
4	191ME321	Engineering Thermodynamics	PC	2	2	0	3
5	191ME322	Manufacturing Technology II	PC	3	0	0	3
6	191ME323	Engineering Metallurgy	PC	3	0	0	3
PRACTICAL							
1	191EE31A	Electrical Engineering Laboratory	ES	0	0	4	2
2	191ME31B	Fluid Mechanics and machinery Laboratory	ES	0	0	4	2
3	191ME32A	Manufacturing Technology Laboratory	PC	0	0	4	2
Total				**15**	**6**	**12**	**24**

SEMESTER- IV

Sl. No	Course Code	Name of the Course	Category	No. of Periods / Week			Credits
				L	T	P	
THEORY							
1	191MA402	Statistics and Numerical Methods	BS	2	2	0	3
2	191ME411	Strength of materials for Mechanical Engineers	ES	3	0	0	3
3	191ME421	Kinematics of Machinery	PC	2	2	0	3
4	191ME422	Computer Aided Design and Manufacturing	PC	3	0	0	3
5	191ME423	Thermal Engineering	PC	3	0	0	3
PRACTICAL							
1	191HS40B	Interpersonal Skills Laboratory	HSS	0	0	2	1
2	191ME41A	Strength of materials Laboratory	ES	0	0	4	2
3	191ME42A	CAD/ CAM Laboratory	PC	0	0	4	2
INTERNSHIP							

1	191MC46A	Internship/ Training -I	MC	0	0	0	0
Total				**13**	**4**	**10**	**20**

SEMESTER – V

Sl.No	Course Code	Name of the Course	Category	No. of Periods / Week			Credits
				L	T	P	
THEORY							
1	191ME521	Design of Machine Elements	PC	3	0	0	3
2	191ME522	Metrology and Measurements	PC	3	0	0	3
3	191ME523	Dynamics of Machines	PC	2	2	0	3
4	-	Professional Elective-I	PE	3	0	0	3
5	191CS5410	Open Elective-I Problem Solving and Python Programming	OE	3	0	0	3
	PRACTICAL						
1	191ME52A	Metrology and Measurements Laboratory	PC	0	0	4	2
2	191ME52B	Kinematics and Dynamics Laboratory	PC	0	0	4	2
Total				**14**	**2**	**8**	**19**

SEMESTER – VI

Sl.No	Course Code	Name of the Course	Category	No. of Periods / Week			Credits
				L	T	P	
THEORY							
1	191ME621	Design of Transmission Systems	PC	3	0	0	3
2	191ME622	Heat and Mass Transfer	PC	3	0	0	3
3	191ME623	Finite Element Analysis	PC	3	0	0	3
4	-	Professional Elective-II	PE	3	0	0	3
5	-	Professional Elective-III	PE	3	0	0	3
6	-	Open Elective-II	OE	3	0	0	3
	PRACTICAL						
1	191ME62A	Finite Element Method Laboratory	PC	0	0	4	2
2	191ME62B	Thermal Engineering Laboratory	PC	0	0	4	2
	INTERNSHIP						
1	191MC66A	Internship/Training-II	MC	0	0	0	0
Total				**18**	**0**	**8**	**22**

SEMESTER – VII

Sl. No	Course Code	Name of the Course	Category	No. of Periods / Week			Credits
				L	T	P	
THEORY							
1	191HS701	Principles of Management	HSS	3	0	0	3
2	191ME721	Power Plant Engineering	PC	3	0	0	3
3	-	Professional Elective-IV	PE	3	0	0	3
4	-	Professional Elective-V	PE	3	0	0	3
5	-	Open Elective-III	OE	3	0	0	3
PRACTICAL							
1	191ME77A	Design and Fabrication Project	PROJ	0	0	4	2
SEMINAR							
1	191MC76A	Technical Seminar	MC	0	0	0	0
Total				**15**	**0**	**8**	**17**

SEMESTER – VIII

Sl. No	Course Code	Name of the Course	Category	No. of Periods / Week			Credits
				L	T	P	
THEORY							
1	-	Professional Elective-VI	PE	3	0	0	3
2	-	Open Elective-IV	OE	3	0	0	3
3	-	Open Elective-V	OE	3	0	0	3
PROJECT							
1	191ME85A	Project Work	PROJ	0	0	20	10
Total				**9**	**0**	**20**	**19**

Total Credits : 161

BASIC SCIENCES (BS)

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	191MA101	Engineering Mathematics I	4	2	2	0	3
2	191PH101	Engineering Physics	3	3	0	0	3
3	191CH101	Engineering Chemistry	3	3	0	0	3
4	191PH10A	Physics Laboratory	2	0	0	2	1
5	191CH10A	Chemistry laboratory	2	0	0	2	1
6	191MA201	Engineering Mathematics II	4	2	2	0	3
7	191PH204	Materials Science for Mechanical Engineering	3	3	0	0	3
8	191MA305	Transforms and Partial Differential Equations	4	2	2	0	3
9	191MA402	Statistics and Numerical Methods	4	2	2	0	3

HUMANITIES AND SOCIAL SCIENCES (HS)

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	191HS101	English for Engineering Students	3	3	0	0	3
2	191HS201	Environmental Science and Engineering	3	3	0	0	3
3	191HS40B	Interpersonal Skills Laboratory	2	0	0	2	1
4	191HS701	Principles of Management	3	3	0	0	3

ENGINEERING SCIENCES (ES)

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	191ME111	Basic Civil and Mechanical Engineering	3	3	0	0	3
2	191EE111	Basic Electrical and Electronics Engineering	3	3	0	0	3
3	191ME211	Engineering Graphics	4	2	2	0	3
4	191ME212	Engineering Mechanics	4	2	2	0	3
5	191ME21A	Engineering Practices Laboratory	4	0	0	4	2
6	191ME311	Fluid Mechanics and Machinery	3	2	2	0	3
7	191EE311	Electrical Drives and Controls	3	3	0	0	3

8	191EE31A	Electrical Engineering Laboratory	4	0	0	4	2
9	191ME31B	Fluid Mechanics and machinery Laboratory	4	0	0	4	2
10	191ME411	Strength of materials for Mechanical Engineers	3	3	0	0	3
11	191ME41A	Strength of materials Laboratory	4	0	0	4	2

PROGRAMME CORE (PC)

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	191ME221	Manufacturing Technology I	3	3	0	0	3
2	191ME321	Engineering Thermodynamics	4	2	2	0	3
3	191ME322	Manufacturing Technology II	3	3	0	0	3
4	191ME323	Engineering Metallurgy	3	3	0	0	3
5	191ME32A	Manufacturing Technology Laboratory	4	0	0	4	2
6	191ME421	Kinematics of Machinery	4	2	2	0	3
7	191ME422	Computer Aided Design and Manufacturing	3	3	0	0	3
8	191ME423	Thermal Engineering	3	3	0	0	3
9	191ME42A	CAD/ CAM Laboratory	4	0	0	4	2
10	191ME521	Design of Machine Elements	3	3	0	0	3
11	191ME522	Metrology and Measurements	3	3	0	0	3
12	191ME523	Dynamics of Machines	4	2	2	0	3
13	191ME52A	Metrology and Measurements Laboratory	4	0	0	4	2
14	191ME52B	Kinematics and Dynamics Laboratory	4	0	0	4	2
15	191ME621	Design of Transmission Systems	3	3	0	0	3
16	191ME622	Heat and Mass Transfer	3	3	0	0	3
17	191ME623	Finite Element Analysis	3	3	0	0	3
18	191ME62A	Finite Element Method Laboratory	4	0	0	4	2
19	191ME62B	Thermal Engineering Laboratory	4	0	0	4	2
20	191ME721	Power Plant Engineering	3	3	0	0	3

PROFESSIONAL ELECTIVES FOR B.E. MECHANICAL ENGINEERING

SEMESTER V, ELECTIVE I

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	191ME531	Automobile Engineering	3	3	0	0	3
2	191ME532	Business Analytics	3	3	0	0	3
3	191ME533	Computer Integrated Manufacturing	3	3	0	0	3
4	**191ME535**	Fundamentals of Nano Science	3	3	0	0	3
5	**191ME534**	Entrepreneurship Development	3	3	0	0	3

SEMESTER VI, ELECTIVE II

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	**191ME631**	Gas Dynamics and Jet Propulsion	3	3	0	0	3
2	**191ME632**	Hydraulics and Pneumatics	3	3	0	0	3
3	**191ME633**	Intellectual Property Rights	3	3	0	0	3
4	**191ME634**	Professional Ethics in Engineering	3	3	0	0	3
5	**191ME635**	Welding Technology	3	3	0	0	3

SEMESTER VI, ELECTIVE III

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	**191ME636**	Refrigeration and Air conditioning	3	3	0	0	3
2	**191ME637**	Renewable Sources of Energy	3	3	0	0	3
3	**191ME638**	Systems Engineering	3	3	0	0	3
4	**191ME639**	Total Quality Management	3	3	0	0	3
5	**191ME6310**	Unconventional Machining Processes	3	3	0	0	3

SEMESTER VII, ELECTIVE IV

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	191ME731	Composite Materials and Mechanics	3	3	0	0	3
2	191ME732	Computational Fluid Dynamics	3	3	0	0	3
3	191ME733	Design of Jigs Fixtures and Press Tools	3	3	0	0	3
4	191ME734	Mechatronics	3	3	0	0	3
5	191ME735	Supply Chain Management	3	3	0	0	3

PROFESSIONAL ELECTIVES FOR B.E. MECHANICAL ENGINEERING

SEMESTER VII, ELECTIVE V

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	**191ME736**	Industrial Safety Engineering	3	3	0	0	3
2	**191ME737**	Noise Vibration and Harshness	3	3	0	0	3
3	**191ME738**	Non Destructive Testing and Evaluation	3	3	0	0	3
4	**191ME739**	Operations Research	3	3	0	0	3
5	**191ME7310**	Product Design and Development	3	3	0	0	3

SEMESTER VIII, ELECTIVE VI

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	191ME831	Engineering Economics	3	3	0	0	3
2	191ME832	Internet of Things for Mechanical Engineering	3	3	0	0	3
3	191ME833	Maintenance Engineering	3	3	0	0	3
4	191ME834	Production Planning and Control	3	3	0	0	3
5	191ME835	Robotics and Automation	3	3	0	0	3

MANDATORY COURSES (MC)

Sl. No	Course Code	Name of the Course	No. of Periods / Week	L	T	P	C
1	191MC46A	Internship/ Training -I	0	0	0	0	0
2	191MC66A	Internship/Training-II	0	0	0	0	0
3	191MC76A	Technical Seminar	0	0	0	0	0

OPEN ELECTIVE (OE)
(Offered to other branches)

Sl. No	Course Code	Name of the Course	No. of Periods/Week	L	T	P	C
1	**191ME541**	Advanced Materials	3	3	0	0	3
2	**191ME542**	Design Thinking	3	3	0	0	3
3	**191ME543**	Energy Conservation and Management	3	3	0	0	3
4	**191ME544**	Lean Six Sigma	3	3	0	0	3
5	**191ME545**	Material Science and Technology	3	3	0	0	3
6	**191ME546**	Renewable Energy Sources	3	3	0	0	3

7	**191ME547**	Testing of Materials	3	3	0	0	3

SUMMARY

Sl. No.	Category	Credits per semester								Credits Total	Percentage %
		I	II	III	IV	V	VI	VII	VIII		
1	BS	11	6	3	3	-	-	-	-	23	14.29 %
2	HSS	3	3	-	1	-	-	3	-	10	6.21 %
3	ES	6	8	1 -	5	-	-	-	-	29	18.01 %
4	PC	-	3	11	11	13	13	3	-	54	33.54 %
5	PE	-	-	-	-	3	6	6	3	18	11.18 %
6	OE	-	-	-	-	3	3	3	6	15	9.32 %
7	PROJ	-	-	-	-	-	-	2	1 -	12	7.45 %
	Total	20	20	14	20	19	22	17	9	23	14.29 %
8	MC										

CREDIT DISTRIBUTION

Sl. No.	Code	Category	Credits (Regular)	Credits (Lateral)
1	BS	Basic Sciences	23	6
2	HSS	Humanities and Social Sciences	10	4
3	ES	Engineering sciences	29	15
4	PC	Programme Core	54	48
5	PE	Programme Electives	18	18
6	OE	Open Electives	15	15
7	PROJ	Project	12	12
8	MC	Mandatory Courses	0	0
Total Credits			**161**	**118**

COURSE CODE	COURSE NAME	L	T	P	C
191MA101	ENGINEERING MATHEMATICS I	2	2	0	3

COURSE OBJECTIVES

- To develop greater knowledge and understanding of mathematics and to attain the skills necessary for success in the study of higher mathematics.

UNIT 1	MATRICES	15

Characteristic equation–Eigen values and Eigen vectors of a real matrix–Properties of Eigen values – Cayley Hamilton theorem- Orthogonal reduction of a symmetric matrix to diagonal form– Reduction of quadratic form by orthogonal transformation –Applications.

UNIT 2	GEOMETRICAL APPLICATIONS OF DIFFERENTIALCALCULUS	15

Curvature–Cartesian and Polar coordinates – Centre of curvature, Circle of curvature – Evolutes and Envelopes-Applications.

UNIT 3	FUNCTIONS OF SEVERAL VARIABLES	15

Function of two variables – Partial derivatives – Total derivative – Change of Variables – Jacobians-Taylor's expansion – Maxima and Minima – Constrained Maxima and Minima by Lagrangian Multiplier method-Applications.

UNIT 4	ORDINARY DIFFERENTIAL EQUATIONS	15

Linear differential equations of second and higher order with constant coefficients – Method of variation of parameters – Equations reducible to linear equations with constant coefficients : Cauchy's homogeneous linear equation and Legendre's linear equation – Simultaneous linear equations with constant coefficients - Applications.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Analyze the characteristics equation of a linear system with Eigen values and vectors for practical application.
CO2	Determine the bending of family of curves using differential calculus which deals in various disciplines.
CO3	Apply partial derivatives in various engineering problems.
CO4	Identify and solve the real time problems using higher order differential equations.

REFERENCES
1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley & Sons. Singapore, 10th edition, 2012. 2. Grewal.B.S, Higher Engineering Mathematics, Khanna Publications, 42nd Edition, 2012. 3. Veerarajan.T, "Engineering Mathematics I", Tata McGraw Hill Publishing Co, New Delhi, 5th edition, 2006. 4. Kandasamy, P., Thilagavathy, K., Gunavathy, K., "Engineering Mathematics", Vol. I (4th revised edition), S. Chand & Co, New Delhi, 2000.

COURSE CODE	COURSE NAME	L	T	P	C
191PH01	ENGINEERING PHYSICS	3	0	0	3

COURSE OBJECTIVES

- The course aims to equip engineering undergraduates with principles of Physics in a broader sense with a view to lay foundation for the various engineering courses

UNIT 1	PROPERTIES OF SOLIDS	9

Elasticity- Hooke's law – stress -strain diagram – Poisson's ratio –Factors affecting elasticity –Bending moment – Depression of a cantilever –Young's modulus by uniform bending- Young's modulus by non-uniform bending (Theory and Experiment) - Torsional stress and twisting couple- Torsional Pendulum ((Theory and Experiment) I-shaped girders.

UNIT 2	PRINCIPLES OF LASERS	9

Properties of laser radiation and their significance-wavelength, power, monochromaticity, coherence. Types of lasers working media and their radiation characteristics-Power, wavelength and operational modes of He-Ne, Carbon-dioxide. Physical principles of Laser beam delivery systems. Applications-Industry and Medical. Selection of lasers for various applications.

UNIT 3	OPTICAL FIBRE SYSTEMS	9

Optical Fibres- Propagation mechanism -Critical Angle- Snell's Law-Total Internal Reflection Acceptance cone- Numerical aperture- Types of fibers- Attenuation-Active and passive fibre sensors (Temperature and Displacement)- Applications (Industry and Medical) - communication in optical fiber- Endoscope.

UNIT 4	WAVE NATURE OF PARTICLES	9

Introduction to Quantum mechanics, Black body radiation- Planck's Hypothesis-Compton Effect (Theory and Experiment) -Wave nature of Particles, Time-dependent and time-independent Schrodinger equation for wave function, Schrodinger equation for one dimensional problems– particle in a box-SEM and TEM.

UNIT 5	SOLID STATE PHYSICS	9

Crystalline and non crystalline materials-Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – Expression for inter planar spacing- Bragg's law- Diffraction of X-rays by crystal planes - Coordination number. Atomic packing factors (SC, FCC, BCC and HCP structures) – Diamond and graphite structures (qualitative treatment) -Crystal growth techniques (Bridgman and Czochralski).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Demonstrate the proficiency on the properties of matter and its applications

CO2	Describe the working principles of Laser and its developments in industrial and medical applications
CO3	Explain the propagation of waves in optical fibres and their applications
CO4	Apply the theory of wave nature of particles in various microscopic applications
CO5	Analyze the structure of materials and its crystal growth techniques

REFERENCES

1. R.K. Gaur and S.L. Gupta, "Engineering Physics", Dhanpat Rai Publications (P) Ltd., 8th Edition. New Delhi, 2001.
2. Charles Kittel, "Introduction to Solid State Physics", 7th Edition, Wiley, Delhi 2007.
3. Halliday, D., Resnick, R. and Walker, J., "Principles of Physics", Wiley, 2015.
4. William T. Silfvast, "Laser Fundamentals" , 2nd Edition, Cambridge University press, New York, 2004.
5. D. Halliday, R. Resnick and J. Walker , "Fundamentals of Physics", 6th Edition, , John Wiley and Sons, New York 2001.
6. E. Hecht, Optics, Pearson Education, 2008.

COURSE CODE	COURSE NAME	L	T	P	C
191CH101	ENGINEERING CHEMISTRY	3	0	0	3

COURSE OBJECTIVES

- To acquaint the students with the new developments of microscopic chemistry in terms of atomic, molecular, orbital and intermolecular forces and acquire the knowledge of water treatment and instrumentation of advanced materials.

UNIT 1	CHEMICAL BONDING	9

Types of chemical bonds - bond polarity- dipole moment – partial ionic character - consequences. Weak Interactions – Hydrogen bonding, Van der Waals forces - influence on properties of matter. Metallic bond – free electron theory, MO treatment - band theory-metals, semiconductors and insulators. Non stoichiometric semiconductors, chalgogen semiconductors. Defect structures of crystals – Schottky and Frenkel defects.

UNIT 2	WATER CHEMISTRY	9

Hardness - determination (EDTA method). Water softening - zeolite and demineralization processes. Desalination by electro-dialysis and reverse osmosis. Water analysis by fluoride ion, Water quality parameters, Instrumental methods for water analysis- AAS, flame emission spectroscopy, ICP-MS and photocolorimetry.

UNIT 3	ELECTROCHEMISTRY	9

Electrode potential – standard and reference electrodes, Nernst equation, emf series – applications. Galvanic and concentration cells. Applications of potential measurements – glass electrode - pH measurement, acid- base titration, redox titration. Conductance measurement – applications – conductometric titrations.

UNIT 4	POLYMERS	9

Classification, degree of polymerization, molecular weight – Mn and Mw. Polymerization reactions. Glass transition temperature – factors affecting Tg - determination by DSC. Polymer processing - compounding, outline of moulding techniques compression, injection, extrusion and blow moulding. Charge transport in conjugated polymers - doped conjugated polymers - glucose biosensor. Polymers for LED and LCD displays.

UNIT 5	ADVANCED MATERIALS	9

Carbon nanotubes and carbon fibres, graphene and polymer nano-composites-properties and applications - morphological studies by SEM and TEM. Solid oxide materials and polymer electrolytes - energy storing applications. Polymer blends and alloys, photo and electroluminescence materials, insulating materials, photopolymers and photoresists for electronics, polymer photovoltaics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Analyse microscopic chemistry in terms of atomic, molecular and Intermolecular forces for real time applications of semiconductors.
CO2	Investigate the various water treatment and softening methods.
CO3	Appraise the types and mechanism of electrochemical reaction in batteries and fuel cells.
CO4	Explain the basic principle, types and mechanism of polymerization process and techniques.
CO5	Assess the properties, characterization and applications of advanced materials for energy storage.

REFERENCES

1. Mary Jane Shultz, "Engineering Chemistry", Cengage Learning, USA, 2009.
2. Palanna O. G., "Engineering Chemistry", Tata Mc.Graw Hill Education Pvt. Ltd., New Delhi, 2009.
3. Gesser, H.D., "Applied Chemistry - A Textbook for Engineers and Technologies", Springer, NY, 2008.
4. Gowarikar V. R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science", New Age International Pvt. Ltd., New Delhi, 2011.
5. Vijayamohanan K. Pillai and Meera Parthasarathy. "Functional Materials - A Chemist's Perspective" Universities Press, India, 2012.
6. Shashi Chawla, "A Text book of Engineering Chemistry", Dhanpat Rai & Co, New Delhi, 2005.

COURSE CODE	COURSE NAME	L	T	P	C
191HS101	ENGLISH FOR ENGINEERING STUDENTS	3	0	0	3

COURSE OBJECTIVES

- Equip students with the English language skills required for the successful undertaking of academic studies.
- Improve general and academic listening skills.
- Provide guidance and practice in basic geranial and classroom conversation and to engage in specific academic speaking activities.
- Strengthen the reading and writing skills of students of engineering

UNIT 1	VOCABULARY BUILDING	9

Word formation - Prefixes and Suffixes – Root words from foreign languages – Synonyms – Antonyms – Compound Nouns – Standard Abbreviations.

UNIT 2	GRAMMATICAL COMPETENCY	9

Noun, Verb, Adjective – Subject-Verb Agreement – Articles – Prepositions – Purpose expressions – Model Verbs.

UNIT 3	BASIC WRITING SKILLS	9

Sentence structure – Phrases – Clauses – Coherence – Cohesion (using linking words) – Paragraph Writing (Descriptive and Narrative).

UNIT 4	READING SKILLS	9

Reading Strategies – Skimming and Scanning – Reading Comprehension exercises with multiple choice and open ended questions – Transforming Information in the form of charts – Note Making.

UNIT 5	ORAL COMMUNICATION	9

(This unit involves interactive practice sessions in Language Lab)

- Listing Comprehension
- Pronunciation, Syllable and Stress, Rhythm and Intonation
- General conversations and dialogues, common in everyday situations
- Short Speech

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
On successful completion of the course, students will be able to	
CO1	Infer meanings of unfamiliar words from context
CO2	Enable to achieve linguistic competence and be able to use grammar as a tool or resource in the comprehension and creation of oral and written discourse efficiently according to the situation.
CO3	Write cohesively, coherently and flawlessly with a wide range of vocabulary and organizing their ideas logically on a topic.
CO4	Activate and reinforce the habit of reading and writing effectively in their discipline.
CO5	Collaborate with multicultural environment

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1. Department of English, Anna University, Mindscapes: English for Technologists and Engineers, Orient Blackswan, Chennai – 2012.
2. Dhanavel, S. P. English and Communication Skills for Students of Science and Engineering, Orient Blackswan, Chennai, 2011.
3. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
4. Practical English Usage. Michael Swan, OUP, 1995.
5. Remedial English Grammar. F.T. Wood. Macmillan.2007.
6. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
7. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press, 2011.

COURSE CODE	COURSE NAME	L	T	P	C
191ME111	BASIC CIVIL AND MECHANICAL ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To create awareness on fundamental knowledge on various domains of civil engineering
- To introduce the sources of water and treatment of water and sewage treatment
- To introduce the fundamentals of power plant engineering
- To introduce the fundamentals of IC engines
- To introduce the fundamentals of energy resources and refrigeration cycles

A. BASICS OF CIVIL ENGINEERING

UNIT 1	SCOPE OF CIVIL ENGINEERING	9

Introduction – Functions and role of Civil Engineer- Branches of Civil Engineering. Materials – Properties, classification and characteristics of building stones, bricks, timber, cement and cement concrete, reinforcing steel- Components of residential building. Foundation – Types and necessity.

UNIT 2	WATER RESOURCES & ENVIRONMENTAL ENGINEERING	9

Sources of water – Hydrologic cycle – Rain water harvesting – importance – methods of rain water harvesting. - Water demand estimation – quality of water – Treatment of water- Water distribution. Sewerage – collection, treatment and disposal of sewage – Septic tanks.

B. BASICS OF MECHANICAL ENGINEERING

UNIT 3	POWER PLANTS, PUMPS AND TURBINES	9

Introduction to Power Plant, Classification of Power Plants – Working principle of steam, Gas, Diesel, Hydro-electric, Geo-thermal and Nuclear Power plants – Merits and Demerits. Pumps and turbines – working principle of single acting and double acting reciprocating pumps – Centrifugal Pump.

UNIT 4	IC ENGINES	9

Introduction to Internal combustion engines – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines.

UNIT 5	RENEWABLE ENERGY AND REFRIGIRATION	9

Introduction to renewable energy sources - Non renewable energy sources-Comparison of Electrical Energy Storage Technologies. Vapour compression Refrigeration system, Vapour absorption refrigeration system.

	TOTAL: 45 PERIODS
COURSE OUTCOMES: On successful completion of the course, students will be able to	
CO1	Explain the usage of construction material and proper selection of construction materials
CO2	Explain about water resources, sewage treatment and transportation systems
CO3	Explain about the components use in power plants
CO4	Describe the internal combustion engines
CO5	Explain about the renewable energy sources and refrigeration cycles

REFERENCES :

1. Shanmugam G and Palanichamy M S, "Basic Civil and Mechanical Engineering", TataMcGraw Hill Publishing Co., New Delhi, 1996.
2. T. Jha and S.K. Sinha, "Construction and Foundation Engineering", Khanna publishers, Delhi, 2003.
3. S.K. Garg, "Water Supply Engineering", Khanna publishers, Delhi, 2005
4. Ramamrutham S., "Basic Civil Engineering", Dhanpat Rai Publishing Co. (P) Ltd. 1999.
5. Seetharaman S., "Basic Civil Engineering", Anuradha Agencies, 2005.
6. Venugopal K. and Prahu Raja V., "Basic Mechanical Engineering", Anuradha Publishers, Kumbakonam, 2000.

COURSE CODE	COURSE NAME	L	T	P	C
191EE111	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To understand the structure of Electric Power Systems
- To execute safety precautions
- To know about construction of meters
- To understand about Electronics and Communication systems

A. ELECTRICAL ENGINEERING

UNIT 1	INDIAN ELECTRICITY SCENARIO	9

Electric Power-Generation resources, Transmission types & Distribution system (levels of voltage, power ratings and statistics)- Regulatory Authorities governing Indian Electricity Protection & Safety-Hazards of electricity-shock, effects of electricity on the human body. Electrical safety practices, Protection devices.

UNIT 2	BASICS OF ELECTRICAL COMPONENTS	9

Evolution of Electricity and Electrical inventions-Charge, Electric potential, voltage, current, power, energy, DC ,AC, time period, frequency, phase, flux, flux density, RMS, Average, Peak, Phasor & Vector diagram.

UNIT 3	BASIC LAWS OF ELECTRIC SYSTEMS& MEASUREMENTS	9

Electric Circuits – Passive components (RLC), Ohm's law, KCL, KVL, Faraday's law, Lenz's law-illustrativeexamples- Analog Moving Iron, Moving Coil and Digital meters–Types and usage.

B. ELECTRONICS ENGINEERING

UNIT 4	BASICS ELECTRONICS	9

Electrical Vs Electronics, Electronic products and systems, Electronic Devices (Diode–Forward bias, reverse bias, Transistor (CE, CB, CC), Electronic components, Electronic Circuits-Rectifier, Regulator &IC-Basic Amplifiers and Oscillators- Communication system Block diagram (Transmitter and Receiver)

UNIT 5	BASICS OF COMMUNICATION ENGINEERING	9

Amplitude Modulation–AM, DSBSC, SSBSC, VSB–PSD, modulators and demodulators–Angle modulation–PM and FM–PSD.

	TOTAL: 45 PERIODS
COURSE OUTCOMES On successful completion of the course, students will be able to	
CO1	Summarizes about different structures of Power system and safety measures.
CO2	Explain about the basics of Electricity
CO3	Discuss on various electric circuits and use of measuring instruments
CO4	Clarify the working of basic electronic devices such as diode, transistor and operational amplifiers
CO5	Infer about Digital Electronics and Communication System

REFERENCES

1. Albert Paul Malvino, "ElectronicPrinciples",TataMcgrawHill,2002
2. Simon Haykin,"CommunicationSystems",WileyEastern,ThirdEdition,1996
3. M.S. Sukhija and T.K. Nagsarkar, Basic Electrical and Electronic Engineering, Oxford, 2016.
4. M. Morris Mano, Digital Design, Third Edition, Pearson Publication.

COURSE CODE	COURSE NAME	L	T	P	C
191PH10A	PHYSICS LABORATORY	0	0	2	1

COURSE OBJECTIVES

- Students will be able to demonstrate an understanding of the scientific method, so that they may use the training beneficial in their higher pursuits

LIST OF EXPERIMENTS

1. Determination of Rigidity modulus – Torsion pendulum.
2. Determination of Young's modulus by non-uniform bending method.
3. Determination of Planck's Constant and work function of materials using photo electric effect Experiment.
4. Determination of wavelength, and particle size using Laser.
5. Determination of acceptance angle in an optical fiber.

Demonstration:

1. Determination of wavelength of mercury spectrum – spectrometer grating.
2. Demonstration of Crystal Growth Technique.
3. Determination of fiber thickness – Air Wedge method.

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

CO1	Apply the principles of properties of matter in determining the various elastic properties
CO2	Have the hands on exercises which helps them to apply principles of optics
CO3	Attains the basic understanding of concepts of quantum mechanics

REFERENCE

1. Wilson J.D. and Hernandez C.A., -"Physics Laboratory Experiments", Houghton Mifflin Company, New York 2005.

COURSE CODE	COURSE NAME	L	T	P	C
191CH10A	CHEMISTRY LABORATORY	0	0	2	1

COURSE OBJECTIVES

To enable the students to understand the basic concepts involved in the analyses

LIST OF EXPERIMENTS

1. Determination of total, permanent, temporary, calcium and magnesium hardness of water by EDTA method.
2. Conductometric titration - determination of strength of an acid.
3. Estimation of iron by potentiometry.
4. Determination of molecular weight of polymer by viscosity average method.
5. Determination of dissolved oxygen in a water sample by Winkler's method.
6. Determination of Na / K in water sample by Flame photometry (Demonstration).
7. Estimation of Copper in ore
8. Estimation of nickel in steel.
9. Determination of total alkalinity and acidity of a water sample.
10. Determination of rate of corrosion by weight loss method.

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

CO1	Acquire knowledge on quantitative chemical analysis by instrumentation and volumetric method
CO2	Analyze the water sample for hardness, chloride, sodium /potassium content, dissolved oxygen etc.
CO3	Solve analytical problems in spectrometer and flame photometer for the identification and quantification

REFERENCE

1. Vogel's Textbook of quantitative chemical Analysis (8th edition, 2014)

COURSE CODE	COURSE NAME	L	T	P	C
191MA201	ENGINEERING MATHEMATICS II	2	2	0	3

COURSE OBJECTIVES

- To understand double and triple integrations and enable them to find area and volume using multiple integrals.
- To know the basics of vector calculus comprising gradient, divergence and curl and line, surface and volume integrals.
- To understand analytic functions of complex variables and conformal mappings.
- To know the basics of residues, complex integration and contour integration.
- To understand Laplace transform and use it to represent system dynamic models and evaluates their time responses.

UNIT 1	MULTIPLE INTEGRALS	12

Double integration – Cartesian and polar coordinates – Change of order of integration –Triple integration in cartesian coordinates.

UNIT 2	VECTOR CALCULUS	12

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields - Simple problems on Vector differentiation–Vector integration - Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs).

UNIT 3	ANALYTIC FUNCTION	12

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy- Riemann equations in Cartesian coordinates and sufficient conditions (excluding proofs)– Properties of analytic function – Construction of analytic function by Milne Thomson method – Conformal mapping : $w = z + c$, cz , $1/z$ and bilinear transformation.

UNIT 4	COMPLEX INTEGRATION	12

Statement and applications of Cauchy's integral theorem and Cauchy's integral formula (excluding proofs) – Taylor's and Laurent's series expansions – Singularities – Residues – Cauchy's residue theorem (excluding proof) – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

UNIT 5	LAPLACE TRANSFORM	12

Laplace transform –Sufficient condition for existence –Transform of elementary functions – Basic properties – Transforms of unit step function and impulse functions –Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem –Initial and final value theorems– Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1	Evaluate multiple integrals using change of variables.
CO2	Apply various integral theorems for solving engineering problems involving cubes and rectangular parallelepipeds.
CO3	Construct analytic functions of complex variables and transform functions using conformal mappings.
CO4	Estimate the real and complex integrals over suitable closed paths and contours.
CO5	Compute solution of linear differential equations using Laplace transform techniques.

REFERENCES

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, Delhi, 42nd Edition, 2012.
2. Kreyzig E., Advanced Engineering Mathematics, John Wiley & Sons (Asia), Pvt, Ltd., Singapore, 10th Edition, 2010.
3. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill, Pub. Co. Ltd., New Delhi, Revised Edition, 2007.
4. Venkataraman M.K., Engineering Mathematics, Volume - II, The National Pub. Co., Chennai, 2003.
5. Kandasamy P., Thilagavathy K. and Gunavathy K., Engineering Mathematics, S. Chand & Co., New Delhi, 2008.
6. Arunachalam T. and Sumathi K., Engineering Mathematics II, Sri Vignesh Publications, Coimbatore, Third Edition, 2011.

COURSE CODE	COURSE NAME	L	T	P	C
191PH204	MATERIALS SCIENCE FOR MECHANICAL ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To introduce the essential principles of materials science for Mechanical engineering applications and become proficient in magnetic, optical and new engineering properties of materials

UNIT 1	MECHANICAL PROPERTIES	9

Concept of Stress and Strain, Elastic and Plastic Deformation, Creep, Hardness, Tensile Strength. Mechanical Testing of Materials: Brinell, Vickers and Rockwell Hardness test, Tensile test and Fatigue test.

UNIT 2	MAGNETIC MATERIALS	9

Magnetic Properties: Permeability, Susceptibility and Magnetic Intensity Classification of magnetic materials-Dia, Para, Ferro, Antiferro and Ferrites- Domain Theory-Hysteresis- Hard and Soft magnetic materials.

UNIT 3	DIELECTRIC MATERIALS	9

Dielectric Constant-Electronic, Ionic and Orientation - Frequency and Temperature dependence of Polarization-Internal field-ClaussiusMosotti Relation- Dielectric Loss-Dielectric Breakdown- Uses of dielectrics (Capacitors and Transformers).

UNIT 4	THERMAL PROPERTIES	9

Heat Capacity and Conductivity. Bimetallic strips and its application-Heat conductions in solids (conduction, convection and radiation)– Thermal conductivity –Through a compound media (Series and Parallel)-Experimental determination Lee's disc method: theory and experiment – Classifications and properties of Insulating materials

UNIT 5	NEW ENGINEERING MATERIALS	9

Metallic Glasses-Types of metallic glasses-Preparation Properties and applications- Shape memory alloys (SMA)-Types- Application of SMA- Superconductors- High Temperature Superconductor and Applications.

DEMO EXPERIMENTS:

1. Band gap of a semiconductor

2. Thermal conductivity of a bad conductor by Lee's disc method

3. Ultrasonic Interferometer used to find the velocity and compressibility of the liquid	
TOTAL: 45 PERIODS	
COURSE OUTCOMES On successful completion of the course, students will be able to	
CO1	Illustrate the adequate concepts of mechanical properties of materials and their measurements
CO2	Examine the importance of magnetic materials in engineering fields by projecting the view of its applications
CO3	Analyze the fundamentals of various dielectric materials, their properties and applications in advanced technologies
CO4	Describe the significance of thermal properties of materials in advanced engineering technologies
CO5	Assimilate recent technological developments, used in creating products from various new engineering materials

REFERENCES

1. Van Vlack L.H., "Elements of Materials Science and Engineering", 6th Edition, Addison- Wesley, 1989.
2. William F Smith, JavadHashemi, Ravi Prakash, "Materials Science and Engineering", Tata McGraw Hill Private Limited, 4th Edition, 2008.

COURSE CODE	COURSE NAME	L	T	P	C
191HS201	ENVIRONMENTAL SCIENCE AND ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To provide the basic knowledge of structure and function of ecosystem and better understanding of natural resources, biodiversity and their conservation practices.
- To describe the need to lead more sustainable lifestyles, to use resources more equitably.
- To helps to create a concern for our environment that will trigger pro-environmental action, including activities we can do in our daily life to protect it.
- To deal the social issues and ethics to develop quality engineer in our country.

UNIT 1	ENVIRONMENT - AN OVERVIEW	9

Ecosystem-concept-structure-function-types. Energy flow in ecosystem. Biodiversity and its conservation- values of biodiversity-threats to biodiversity conservation of biodiversity. Natural resources- types, uses.

UNIT 2	ENVIRONMENTAL IMPACT OF ENERGY SOURCES	9

Sources of primary energy- present and future consumption of energy- environmental impacts of energy development- oil, natural gas, coal, hydro electric, nuclear power, wind mill and solar panels- Urban problems related to energy - case studies.

UNIT 3	CLIMATIC CHANGE AND SOLID WASTE MANAGEMENT	9

Environmental pollution- air, water, soil, marine and noise pollution-green house gases- causes, effects-global warming, ozone layer depletion, acid rain-sources and effects. Pollution control strategies-preventive measures- green technologies-green building concepts- standards and regulations- role of individuals. Sustainable development. Hazardous wastes- e-waste- source-effect, management. Nuclear waste-sources, effects, management. Recycling of waste. Future challenges.

UNIT 4	HUMAN POPULATION AND THE ENVIRONMENT	9

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.

UNIT 5	ENVIRONMENTAL LAWS AND ETHICS	9

Legal provision in India- environmental acts-air, water, forest, soil and wildlife. Environmental ethics-theories and codes- resource consumption patterns, equity-disparity, urban-rural equity issues, need for gender equity, preserving resource for future generation, right of animals, ethical basis of environment education and awareness, ethical problem solving- changing attitude, conservation ethics and traditional value systems of India. Effect of social media on the adolescent.

	TOTAL: 45 PERIODS
COURSE OUTCOMES On successful completion of the course, students will be able to	
CO1	Interpret the concept of ecosystem, biodiversity and its conservation.
CO2	Demonstrate the environmental impacts of energy development.
CO3	Categorize the various environmental pollutions and select suitable preventive measures.
CO4	Perceive the environmental effects of human population and the implementation of welfare programs.
CO5	Recall the environmental ethics and legal provisions.

REFERENCES

1. Erach Bharucha, "Text book for Environmental sciences for Undergraduate courses", UGC, 2004.
2. Kaushik, A &Kaushik, CP, Environmental Science and engineering", 3rd Edition, New Age International (P) Limited, New Delhi, 2009.
3. Henry, JG &Heinke, GW, "Environmental Science and Engineering", 2nd Edition, PHI Learning Private limited, New Delhi, 2011.
4. Masters, GM & Ela, WP, "Introduction to Environmental Engineering and Science", 3rd Edition, PHI Learning Private limited, New Delhi, 2009.
5. Encyclopedia of environmental ethics and philosophy. Available at www.gmu.ac.ir/download/ booklibrary/e-library/Encyclopedia of Environmental Ethics and philosophy.pdf

COURSE CODE	COURSE NAME	L	T	P	C
191ME211	ENGINEERING GRAPHICS	2	2	0	3

COURSE OBJECTIVES

- To convey the basics of engineering drawing of curves and concepts of free hand sketching
- To teach different methods of making views of simple objects resembling points, lines and surfaces
- To relate the visualizations of simple solid objects as per principles of orthographic projection
- To establish the importance of sections and developments made in drawing
- To develop an intuitive understanding of underlying significance of using pictorial drawings

CONCEPTS AND CONVENTIONS (Not for Examination)

Introduction to engineering graphics- Importance of graphics in engineering applications – Use of drafting instruments -Size and layout of drawing sheets. BIS Standards - Lettering and dimensioning.

UNIT 1	PLANE CURVES AND FREE HAND SKETCHING	12

Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views-Free hand sketching of multiple orthographic views from single pictorial view of objects.

UNIT 2	PROJECTION OF POINTS, LINES AND PLANE SURFACES	12

Orthographic projections - Introduction - Principles -Principal planes-First angle projection. Projection of points located in all quadrants. Projection of straight lines inclined to both the principal planes, Determination of true lengths and true inclinations by rotating line method, traces. Projection of planes (regular polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT 3	PROJECTION OF SOLIDS	12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT 4	SECTION OF SOLIDS & DEVELOPMENT OF LATERAL SURFACE OF SOLIDS	12

Sectioning of simple solids in vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids like Prisms, pyramids, cylinders and cones.

UNIT 5	ISOMETRIC AND PERSPECTIVE PROJECTIONS	12

Principles of isometric projection – Isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, and cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids like Prisms, pyramids and cylinders by visual ray method.

	TOTAL: 60 PERIODS
COURSE OUTCOMES: On successful completion of the course, students will be able to	
CO1	Draw engineering curves and apply the concepts of free hand sketching
CO2	Draw orthographic views of points, lines and surfaces
CO3	Draw visualizations of simple solid objects as per orthographic projections
CO4	Draw sections and developments made in drawing
CO5	Draw pictorial drawings of simple objects

REFERENCES

1. N.D. Bhatt, Engineering Drawing, 49th edition, Charotar Publishing House, 2006.
2. Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
3. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
4. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.
5. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.

COURSE CODE	COURSE NAME	L	T	P	C
191ME212	ENGINEERING MECHANICS	2	2	0	3

COURSE OBJECTIVES

- To develop capacity to predict the forces and motion in the course of carrying out the design functions of engineering
- To develop the understanding of forces using free body diagrams
- To suggest suitable methods for identifying properties of surfaces and solids from first principle and apply to moment of inertia
- To develop the concepts of dynamic forces in rigid body
- To introduce the concepts of friction in simple systems, velocity and acceleration in rigid body subjected to dynamic forces

UNIT 1	STATICS OF PARTICLES	12

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.

UNIT 2	EQUILIBRIUM OF RIGID BODIES	12

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force - Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

UNIT 3	PROPERTIES OF SURFACES AND SOLIDS	12

Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula – Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT 4	DYNAMICS OF PARTICLES	12

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT 5	FRICTION AND RIGID BODY DYNAMICS	12

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Apply the vectorial and scalar representation of forces and moments to practical problems
CO2	Solve the equilibrium of rigid bodies in practical applications
CO3	Relate the moment related properties for simple surfaces and simple problems
CO4	Find dynamic forces exerted in rigid body in practical problems
CO5	Identify the conditions of static and dynamic bodies using laws of friction in practical problems

REFERENCES :

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing Company, New Delhi (2004).
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010)
3. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education, 2010.
4. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education 2006.
5. Meriam J.L. and Kraige L.G., "Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons, 1993.
6. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.
7. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
8. Kumar, K.L.,"Engineering Mechanics",3rd Ed, TataMcGrawHill Publishing Company, New Delhi 2008.

COURSE CODE	COURSE NAME	L	T	P	C
191ME221	MANUFACTURING TECHNOLOGY I	2	2	0	3

COURSE OBJECTIVES

- To introduce about the pattern and concepts of metal casting processes
- To introduce the concepts of metal joining processes
- To introduce about various hot working and cold working methods of metals
- To provide knowledge on the drawing and sheet metal forming of metal components
- To introduce various methods of manufacturing plastic components

UNIT 1	METAL CASTING PROCESSES	12

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding s and Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO2 process –Stir casting; Defects in Sand casting.

UNIT 2	METAL JOINING PROCESSES	12

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.

UNIT 3	METAL FORMING PROCESSES	12

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion.

UNIT 4	SHEET METAL PROCESSES	12

Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming.

UNIT 5	MANUFACTURE OF PLASTIC COMPONENTS	12

Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding – Typical industrial applications – introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Explain different metal casting processes, associated defects, merits and demerits
CO2	Compare different metal joining processes
CO3	Summarize various hot working and cold working methods of metals
CO4	Explain various sheet metal making processes.
CO5	Distinguish various methods of manufacturing plastic components

REFERENCES

1. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2008.
2. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2013.
3. Gowri P. Hariharan, A.Suresh Babu, "Manufacturing Technology I", Pearson Education, 2008.
4. Paul Degarma E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing" Eight Edition, Prentice – Hall of India, 1997.
5. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-2013
6. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006
7. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014.

COURSE CODE	COURSE NAME	L	T	P	C
191ME21A	ENGINEERING PRACTICES LABORATORY	0	0	4	2

COURSE OBJECTIVES

- To provide exposure to the students with hands-on experience on various basic engineering practices in civil and mechanical engineering.
- To provide exposure to the students with hands-on experience on various basic engineering practices in electrical and electronics engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE

Buildings: (a) Study of plumbing and carpentry components of residential and industrial buildings, Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.

(b) Study of pipe connections requirements for pumps and turbines.

(c) Preparation of plumbing line sketches for water supply and sewage works.

(d) Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry (using power tools only):

(a) Study of the joints in roofs, doors, windows and furniture.

(b) Hands-on-exercise: Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE

Welding: (a) Preparation of butt joints, lap joints and T- joints by shielded metal arc welding.

(b) Gas welding practice

Basic Machining: (a) Simple Turning and Taper turning

(b) Drilling Practice

Sheet Metal Work: (a) Forming & Bending:

(b) Model making – Trays and funnels.

(c) Different type of joints.

Machine assembly practice: (a) Study of centrifugal pump

(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example –

Exercise – Production of hexagonal headed bolt.

(b) Foundry operations like mould preparation for gear and step cone pulley.

Fitting – Exercises – Preparation of square fitting and V – fitting models

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, RMS period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Use mechanical and civil engineering equipments to join the structures and perform basic machining operations and fabricate models in sheet meta
CO2	Use electrical and electronics engineering equipments to test the respective electrical and electronic parameters

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings	10 Nos.
2	Carpentry vice (fitted to work bench)	10 Sets
3	Standard woodworking tools	15 Each
4	Models of industrial trusses, door joints, furniture joints	5 Nos.
5	Power Tools: a) Rotary Hammer b) Demolition Hammer c) Circular Saw d) Planer e) Hand Drilling Machine f) Jigsaw	 2 Nos. 2 Nos. 2 Nos. 2 Nos. 2 Nos.

MECHANICAL

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Arc welding transformer with cables and holders	5 Nos.
2	Welding booth with exhaust facility	5 Nos.
3	Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit	1 No.
5	Centre lathe	2 Nos.
6	Hearth furnace, anvil and smithy tools	2 Nos.
7	Moulding table, foundry tool	2 Nos.
8	Power Tool: Angle Grinder	2 Nos.
9	Study-purpose items: centrifugal pump, air-conditioner	One each

ELECTRICAL

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Assorted electrical components for house wiring	7 Sets
2	Electrical measuring instruments	10 Sets
3	Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4	Megger	1 No.

5	Digital Live-wire detector	1 No.

ELECTRONICS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Soldering guns	10 Nos.
2	Assorted electronic components for making circuit	50 Nos.
3	Small PCBs	10 Nos.
4	Multimeters	10 Nos.
5	Study purpose items: Telephone, FM radio, AFO, CRO, RPS, meters	One each

COURSE CODE	COURSE NAME	L	T	P	C
191MA305	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	2	2	0	3

COURSE OBJECTIVES

- To introduce Fourier series analysis this is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes.

UNIT 1	FOURIER SERIES	12

Fourier series - Dirichlet's conditions –Half range Fourier cosine and sine series – Parseval's relation – Fourier series in complex form – Harmonic analysis.

UNIT 2	FOURIER TRANSFORMS	12

Fourier transforms - pair – Fourier cosine and sine transforms – inverse transforms - convolution theorem and Parseval's identity for Fourier transforms– Finite cosine and sine transforms identity.

UNIT 3	PARTIAL DIFFERENTIAL EQUATIONS	12

Formation of PDE - Solutions of standard types of first order equations - Lagrange's linear equation – Second and higher order homogeneous and non-homogeneous linear equations with constant coefficients.

UNIT 4	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS-I	12

One dimensional wave equation and one dimensional heat flow equation – Method of separation of variables – Fourier series solution.

UNIT 5	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS-II	12

Twodimensional heat flow equation in steady state. Laplace equation in Cartesian and polar coordinates - Method of separation of variables – Fourier series solution.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Solve the given standard partial differential equations

CO2	Solve differential equations using Fourier series analysis for engineering applications
CO3	Apply mathematical principles on transforms and partial differential equations
CO4	Solve one and two dimensional heat flow problems and wave equations using Fourier series
CO5	Solve partial differential equations by using Z transform techniques for discrete time systems

REFERENCES :

1. Grewal.B.S, Higher Engineering Mathematics, Khanna Publications, 43rd Edition, 2014.
2. N.P. Bali. and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, LaxmiPublications Pvt. Ltd, 2007.
3. B.V Ramana.., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2008.

COURSE CODE	COURSE NAME	L	T	P	C
191ME311	FLUID MECHANICS AND MACHINERY	2	2	0	3

COURSE OBJECTIVES

- To introduce concepts about properties of fluids and control volume.
- To demonstrate the applications of the conservation laws to flow through pipes.
- To discuss on the importance of dimensional analysis
- To discuss the importance of various types of flow in pumps.
- To discuss the importance of various types of flow in turbines.

UNIT 1	PROPERTIES OF FLUID AND ITS SIGNIFICANCE	12

Properties of fluids, Flow characteristics– concept of control volume - application of continuity equation, energy equation and momentum equation, Euler equation.

UNIT 2	FLOW THROUGH CIRCULAR CONDUITS	12

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli, boundary layer concepts – types of boundary layer thickness – Darcy-Weisbach equation –friction factor- Moody diagram- commercial pipes- minor losses – flow through pipes in series and parallel, different geometry, laminar and turbulent flow, hydraulic diameter.

UNIT 3	INTRODUCTION TO DIMENSIONAL ANALYSIS	12

Dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

UNIT 4	PUMPS	12

Impact of jets - Euler's equation - theory of roto-dynamic machines – various efficiencies– velocity triangles - dimensional analysis of a pump, centrifugal pumps– working principle - work done by the impeller - performance curves – Reciprocating and rotary pumps - working principles.

UNIT 5	TURBINES	12

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines, pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner – draft tube. Specific speed - performance curves for turbines – governing of turbines, introduction to micro-hydro turbines.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Apply mathematical knowledge to predict the properties and characteristics of a fluid
CO2	Analyze and calculate major and minor losses associated with incompressible fluid flow in piping networks
CO3	Calculate mathematically and predict the nature of physical quantities
CO4	Analyze the performance of hydraulic pumps
CO5	Analyze the performance of hydraulic turbines

REFERENCES

1. Modi, P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", standard book house, New Delhi, 2013.
2. Bansal, R.K, "A text book of fluid mechanics and Hydraulic machines", Laxmi publications (P) Ltd., 2010.
3. Kumar, K. L., "Engineering fluid mechanics", Eurasia publishing house(p) Ltd., New Delhi, 2016.
4. Streeter, V. L. and Wylie E. B., "Fluid mechanics", McGraw hill publishing Co., 2010.

COURSE CODE	COURSE NAME	L	T	P	C
191EE311	ELECTRICAL DRIVES AND CONTROLS	3	0	0	3

COURSE OBJECTIVES

- To understand the basics of drive control and braking concepts of different types of electrical machines and their performance.
- To study the different methods of starting D.C motors and induction motors.
- To study the conventional and solid-state drives speed control methods.

UNIT 1	INTRODUCTION	9

Basic Elements – Types of Electric Drives -Application of Electrical Drive– factors influencing the choice of electrical drives– Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors– heating and cooling curves.

UNIT 2	DRIVE MOTOR CHARACTERISTICS AND BRAKING	9

Electrical and Mechanical characteristics of various types of load and drive motors – Braking of DC motors: Shunt, series and compound – Braking of AC motors: Single phase and Three phase induction motors.

UNIT 3	MOTOR STARTING METHODS	9

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Types of A.C Motor starters – Three phase squirrel cage and slip ring induction motors.

UNIT 4	CONVENTIONAL SPEED CONTROL OF DRIVE MOTORS	9

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system– Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme.

UNIT 5	SOLID STATE SPEED CONTROL OF DRIVE MOTORS	9

Speed control of DC series and shunt motors –Using controlled rectifiers and DC choppers – applications. Speed control of three phase induction motor – slip power recovery scheme – Using inverters and AC voltage regulators – applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, students will be able to	
CO1	Analyze the rating and class of duty of machines for particular application of electrical drive and draw the heating and cooling curves.
CO2	Explain the mechanical & electrical characteristics of DC & AC machines for application on electrical drive.
CO3	Describe the starting methods of both DC and AC machines.
CO4	Classify conventional control and solid state speed control for DC drives.
CO5	Apply speed control on DC and AC drive by conventional and solid state methods.

REFERENCES

1. Vedam Subrahmaniam, "Electric Drives (concepts and applications)", Tata McGraw-Hill, 2001
2. Nagrath .I.J. & Kothari .D.P, "Electrical Machines", Tata McGraw-Hill, 1998
3. Dubey.G.K."Fundamentals of Electrical Drives", Alpha science International ltd. Second edition.
4. Pillai.S.K "A first course on Electric drives", Wiley Eastern Limited, 1998
5. Singh. M.D., K.B.Khanchandani, "Power Electronics", Tata McGraw-Hill, 1998
6. Partab. H., "Art and Science and Utilisation of Electrical Energy", Dhanpat Rai and Sons, 1994

COURSE CODE	COURSE NAME	L	T	P	C
191ME321	ENGINEERING THERMODYNAMICS	2	2	0	3

(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)

COURSE OBJECTIVES

- To discuss about thermodynamic systems and properties, relationships among the thermos-physical properties, the laws of thermodynamics and applications of these basic laws in thermodynamic systems.
- To familiarize the students to understand the fundamentals of thermodynamic systems and to perform thermal analysis on their behavior and performance.

UNIT 1	BASIC CONCEPTS AND FIRST LAW	9

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach, path and point functions. intensive and extensive properties, total and specific quantities. system and their types, thermodynamic equilibrium, State, path and process, quasi-static, reversible and irreversible processes, heat and work transfer, definition and comparison, sign convention, displacement work and other modes of work .P-V diagram, zeroth law of thermodynamics, thermal equilibrium– relationship between temperature scales, first law of thermodynamics –application to closed and open systems – steady and unsteady flow processes.

UNIT 2	SECOND LAW AND AVAILABILITY ANALYSIS	9

Heat reservoir, source and sink, heat engine, refrigerator, heat pump, statements of second law and its corollaries. Carnot cycle, reversed Carnot cycle, performance. concept of entropy, Clausius inequality, T-s diagram, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy. applications of second law, high and low grade energy, available and non-available energy of a source and finite body, energy and irreversibility, energy analysis of simple system.

UNIT 3	PROPERTIES OF PURE SUBSTANCE	9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams, p-v-T surface, use of steam table and Mollier chart, Determination of dryness fraction using calorimeter.

UNIT 4	IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS	12

Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties. Compressibility factor-.Principle of Corresponding states -generalized compressibility chart and its use-. Maxwell relations, Tds Equations, difference and ratio of heat capacities, energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation.

UNIT 5	GAS MIXTURES AND PSYCHROMETRY	12
Mole and Mass fraction, Dalton's and Amagat'sLaw, Properties of gas mixture, Psychrometric properties, Psychrometric charts, Property of air vapour mixtures by using chart and expressions, Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing, Applications.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Apply the first law of thermodynamics for simple open and closed systems under steady
CO2	Apply second law of thermodynamics to open and closed systems and calculate entropy
CO3	Apply Rankine cycle to steam power plant and compare few cycle improvement methods
CO4	Derive simple thermodynamic relations of ideal and real gases
CO5	Calculate the properties of gas mixtures and moist air and its use in psychometrics

REFERENCES

1. Nag, P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw-Hill, New Delhi, 2013
2. Yunus A.Cengel & Michael A. Boles, "Thermodynamics", 8th edition 2015.
3. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2016.
4. Rajput, R.K, "A Text Book of Engineering Thermodynamics ", Fifth Edition, 2017.

COURSE CODE	COURSE NAME	L	T	P	C
191ME322	MANUFACTURING TECHNOLOGY II	3	0	0	3

COURSE OBJECTIVES

- To learn the metal cutting theory and calculate the forces involved in it.
- To study construction, working and operations of centre, semi-automatic and automatic lathes.
- To provide the knowledge on construction, working of milling and gear cutting machines.
- To impart knowledge on construction, working and operations of reciprocating, drilling and boring machines.
- To provide knowledge on construction, working of broaching, grinding and few fine finishing processes.

UNIT 1	THEORY OF METAL CUTTING	9

Introduction - material removal processes: Nomenclature of a single point cutting tool and multipoint types of chip formation- Mechanisms of metal cutting- Merchants Circle - Deriving the forces, calculations. Cutting tool - Reasons for failure of cutting tools and form of wear- variables affecting tool life -mechanisms of wear- single point tool and multipoint nomenclature, Cutting fluids - Types and its properties.

UNIT 2	CENTER LATHE AND WORK HOLDING DEVICES	9

Introduction – Types - Centre Lathe - Construction, specification, operations. special attachments, Capstan and turret lathes – automats – single spindle, Swiss type, automatic screw type, multi spindle. Calculation of machining time - Capstan and turret lathes Work holding devices - Concept of Jigs and Fixtures and its applications.

UNIT 3	ABRASIVE PROCESSES AND GEAR CUTTING	9

Abrasive processes: Introduction-Grinding wheel: types of grinding machines – cylindrical grinding, surface grinding, centre less grinding –Grinding Process parameters- honing, lapping, super finishing, polishing and buffing, - Gear cutting, forming, generation, shaping, hobbing

UNIT 4	DRILLING AND BORING MACHINES	12

Drilling – Introduction, Reaming, Boring, and Tapping –Other Hole-Making Operations- Sawing machine: hack saw, band saw, circular saw-Broaching machines: broach construction – push, pull, surface and continuous broaching machines.

UNIT 5	NON - TRADITIONAL MACHINING	12

Need for Non Traditional Machining, Electric-Discharge Machining (EDM) -Electrochemical Machining-Ultrasonic Machining-chemical Machining-Laser Beam machining, Abrasive Water Jet machining (AWJM), electron Beam Machining (EBM), Ion Beam Machining (IBM), Plasma Arc

Machining (PAM)-Equipments- Process- Process Parameters and Machining Characteristics, Applications, Limitations	
TOTAL: 45 PERIODS	
COURSE OUTCOMES: On successful completion of the course, students will be able to	
CO1	Apply the concepts on theory of metal cutting.
CO2	Analyse various operation in turning.
CO3	Explain the working principles of machine tools.
CO4	Elaborate on various surface finishing operations.
CO5	Apply the fundamental concepts of non-traditional machining.

REFERENCES

1. S. K. Hajra Choudhury, Elements of Workshop Technology. Vol. II, Media Promoters & Publishers Private Limited., Mumbai, 2013.
2. P N Rao, ―Manufacturing Technology – Metal Cutting & Machine Tools , Third Edition, Tata McGraw-Hill Publishing Company Limited, 2013.
3. SeropeKalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Pearson Education Limited. New Delhi, 2013.
4. P.C Sharma, Manufacturing Technology - II, S.Chand& Company Limited. New Delhi, 2012.
5. Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2007.

COURSE CODE	COURSE NAME	L	T	P	C
191ME323	ENGINEERING METALLURGY	3	0	0	3

COURSE OBJECTIVES

- To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

UNIT 1	ALLOYS AND PHASE DIAGRAMS	9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – carbon equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application.

UNIT 2	HEAT TREATMENT	9

Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test - Austempering, martempering – case hardening, carburizing, Nitriding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening.

UNIT 3	FERROUS AND NON-FERROUS METALS	9

Effect of alloying additions on steel- α and β stabilisers– stainless and tool steels – HSLA, Maraging steels – Cast Iron - Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

UNIT 4	NON-METALLIC MATERIALS	9

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON –Composites-Classifications-Metal Matrix and FRP - Applications of Composites.

UNIT 5	MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS	9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Impact test lzod and charpy, fatigue and creep failure mechanisms.

Total: 45 PERIODS

COURSE OUTCOMES:	
On successful completion of the course, students will be able to	
CO1	Explain the basics of phase diagram and apply the knowledge of FeC diagram to understand the relationship between microstructure, properties and application of steel and cast iron
CO2	Apply the various heat treatment processes
CO3	Explain the effect of alloying elements on ferrous alloys and non ferrous alloys
CO4	Elaborate the properties and application of polymers, ceramics and composites
CO5	Explain the mechanisms of deformation and fracture and also compare various methods to determine the mechanical properties

REFERENCES

1. Avner, S.H., “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 1997.
2. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian Edition 2014
3. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 2010.
4. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt. Ltd., 2015.
5. U.C.Jindal: Material Science and Metallurgy, "Engineering Materials and Metallurgy", First Edition, Dorling Kindersley, 2012.
6. Upadhyay. G.S. and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt. Ltd., New Delhi, 2006.

COURSE CODE	COURSE NAME	L	T	P	C
191EE31A	ELECTRICAL ENGINEERING LABORATORY	0	0	4	2

COURSE OBJECTIVES

- To validate the principles studied in theory by performing experiments in the laboratory
- To study the efficiency, voltage regulation of Electrical Machine

LIST OF EXPERIMENTS

1. Load test on DC Shunt motor
2. Load test on DC Series motor
3. O.C.C & Load characteristics of DC Shunt generator
4. Speed control of DC shunt motor (Armature, Field control)
5. Load test on single phase transformer
6. O.C & S.C Test on a single phase transformer
7. Regulation of an alternator by EMF & MMF methods.
8. V curves and inverted V curves of synchronous Motor
9. Load test on three phase squirrel cage Induction motor
10. Speed control of three phase slip ring Induction Motor
11. Study of DC Starters
12. Study of AC Starters

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Observe the performance of various DC machines and Transformer by conducting no load , load test and OC, SC test respectively
CO2	Estimate the losses occurring on machines
CO3	Elaborate about starters based on the machine and power rating

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	DC Shunt motor	2 No.
2	DC Series motor	1 No.
3	DC Shunt motor - DC Shunt generator ser	1 No.
4	DC Series motor - DC Series generator ser	1 No.
5	Single phase transformer	2 No.
6	Three Phase alternator	2 No.
7	Three Phase synchronous motor	1 No.
8	Three phase squirrel cage induction motor	1 No.
9	Three phase slip ring induction Motor	1 No.

COURSE CODE	COURSE NAME	L	T	P	C
191ME31B	FLUID MECHANICS AND MACHINERY LABORATORY	0	0	4	2

COURSE OBJECTIVES

- To verify the principles studied in fluid mechanics theory by performing experiments

.LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orifice meter
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump/ submergible pum
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
6. Conducting experiments and drawing the characteristic curves of Pelton wheel.
7. Conducting experiments and drawing the characteristic curves of Francis turbine
8. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

Total: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Use the measurement equipments for flow measurement
CO2	Perform test on different pumps and turbines

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Orifice meter setup	1 No.
2	Venturimeter setup	1 No.
3	Rotameter setup	1 No.
4	Pipe Flow analysis setup	1 No.
5	Centrifugal pump/submergible pump setup	1 No.
6	Reciprocating pump setup	1 No.
7	Gear pump setup	1 No.
8	Pelton wheel setup	1 No.
9	Francis turbine setup	1 No.
10	Kaplan turbine setup	1 No.

COURSE CODE	COURSE NAME	L	T	P	C
191ME32A	MANUFACTURING TECHNOLOGY LABORATORY	0	0	4	2

COURSE OBJECTIVES

- To Study and practice the various operations that can be performed in lathe, shaper, milling machines and in special purpose machines to equip with the practical knowledge required in the core industries
- To demonstrate the sand moulding techniques and metal joining using arc welding.

LIST OF EXPERIMENTS

Machining and Machining time estimations for:

1. Taper Turning
2. External &Internal Thread Cutting
3. Eccentric Turning
4. Knurling
5. Square/Hexagonal Head Shaping
6. Measurement of cutting forces in Milling / Turning Process
7. Joining of plates and pipes using Arc Welding
8. Preparation of green sand moulds
9. Contour milling using vertical milling machine
10. Spur gear cutting in milling machine
11. Gear generation in hobbing machine
12. Plain Surface grinding
13. Cylindrical grinding
14. Tool angle grinding with tool and Cutter Grinder

Total: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Use different machine tools to manufacturing gears
CO2	Use different machine tools for finishing operations and manufacture tools using cutter grinder

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Centre Lathes	7 Nos.
2	Shaper	1 No.
3	lathe Tool Dynamometer	1 No.
4	Milling Tool Dynamometer	1 No.
5	Arc welding transformer with cables and holders	1 No.
6	Moulding table, Moulding equipments	2 Nos.
7	Horizontal Milling Machine	1 No.
8	Vertical Milling Machine	1 No.
9	Gear Hibbing Machine	1 No.
10	Surface Grinding Machine	1 No.
11	Cylindrical Grinding Machine	1 No.
12	Tool and cutter grinder.	1 No.

COURSE CODE	COURSE NAME	L	T	P	C
191MA402	STATISTICS AND NUMERICAL METHODS	2	2	0	3

COURSE OBJECTIVES

- The ability to identify, reflect upon, evaluate and apply different types of information and knowledge to form independent judgments. analytical, logical thinking and conclusions based on quantitative information will be the main objective of learning this subject.

UNIT 1	TESTING OF HYPOTHESIS	12

Sampling distributions- Large sample test: Tests for mean- Small sample tests: Tests for mean (t test), F- test- Chi-square test for Goodness of fit and Independence of attributes

UNIT 2	DESIGN OF EXPERIMENTS	12

Analysis of Variance - One way and two way classifications - Completely randomized design – Randomized block design – Latin square design

UNIT 3	NUMERICAL SOLUTION TO EQUATIONS	12

Solution of algebraic and transcendental equations: Newton- Raphson method - Solution of system of linear equations: Gauss elimination method - Inverse of a matrix: Gauss-Jordan method- Eigen values of a matrix by Power method.

UNIT 4	INTERPOLATION, DIFFERENTIATIONAND INTEGRATION	12

Interpolation: Newton's forward and backward interpolation formulae - Numerical differentiation: Newton’s forward and backward interpolation formulae. Numerical integration: Trapezoidal rule- Simpson's rules for single integrals- Two point Gaussian quadrature formula.

UNIT 5	NUMERICAL SOLUTIONS OF DIFFERENTIAL EQUATIONS	12

Solution of first order ordinary differential equations: Fourth order Runge- Kutta method - Solution of partial differential equations: Elliptic equations: Poisson’s equation- Parabolic equations by Crank Nicholson method- Hyperbolic equations by explicit finite difference method.

Total: 45 Periods

COURSE OUTCOMES:

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

CO1	Apply the concept of testing of hypothesis for small and large samples in real life problems

CO2	Analyze the basic concepts of Design of Experiments
CO3	Solve algebraic and transcendental equations and Eigen-value problems
CO4	Apply the numerical techniques of differentiation and integration for engineering problem
CO5	Apply various techniques and methods for solving first and second order ordinary differential equations

REFERENCES

1. Grewal. B.S. and Grewal. J.S., “Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
3. Burden, R.L and Faires, J.D, "Numerical Analysis”, 9th Edition, Cengage Learning, 2016.
4. Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014.
5. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 2006.
6. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum’s Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 2004.

Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., “Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.

COURSE CODE	COURSE NAME	L	T	P	C
191ME411	STRENGTH OF MATERIALS FOR MECHANICAL ENGINEERS	3	0	0	3

COURSE OBJECTIVES

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT 1	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT 2	TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM	9

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT 3	TORSION	9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT 4	DEFLECTION OF BEAMS	9

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy.

UNIT 5	THIN CYLINDERS, SPHERES AND THICK CYLINDERS	9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lame's theorem.

Total: 45 Periods

COURSE OUTCOMES:	
Upon the completion of this course the students will be able to	
CO1	Apply the concepts of stress, strain, principal stresses and principal planes
CO2	Explain the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses
CO3	Determine stresses and deformation in circular shafts and helical spring due to torsion
CO4	Compute slopes and deflections in determinate beams by various methods
CO5	Analyze the stresses and deformations induced in thin and thick shells

REFERENCES

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009
3. Ferdinand P. Beer, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing ‘co. Ltd., New Delhi, 2005.
4. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
5. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

COURSE CODE	COURSE NAME	L	T	P	C
191ME421	KINEMATICS OF MACHINERY	2	2	0	3

COURSE OBJECTIVES

- To understand the basic components and layout of linkages in the assembly of a system machine.
- To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.

UNIT 1	BASICS OF MECHANISMS	12

Classification of mechanisms – Basic kinematic concepts and definitions –Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Universal Joint – rocker mechanisms.

UNIT 2	KINEMATICS OF LINKAGE MECHANISMS	12

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration.

UNIT 3	KINEMATICS OF CAM MECHANISMS	12

Classification of cams and followers – Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.

UNIT 4	GEARS AND GEAR TRAINS	12

Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions –Gear tooth action – contact ratio – Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains.

UNIT 5	FRICTION IN MACHINE ELEMENTS	12

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads –Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes- Band and Block brakes.
Total: 60 Periods

COURSE OUTCOMES:	
Upon the completion of this course the students will be able to	
CO1	Discuss the basics of mechanisms
CO2	Calculate velocity and acceleration in simple mechanisms
CO3	Develop CAM profiles
CO4	Solve problems on gears and gear trains
CO5	Examine friction in machine elements

REFERENCES

1. F.B. Sayyad, “Kinematics of Machinery”, MacMillan Publishers Pvt Ltd., Tech-max Educational resources, 2011.
2. Rattan, S.S, “Theory of Machines”, 4th Edition, Tata McGraw-Hill, 2014.
3. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 4th Edition, Oxford University Press, 2014.
4. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.

COURSE CODE	COURSE NAME	L	T	P	C
191ME422	COMPUTER AIDED DESIGN AND MANUFACTURING	3	0	0	3

COURSE OBJECTIVES

- To provide an overview of how computers are being used in mechanical component design
- To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system

UNIT 1	INTRODUCTION	9

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations homogeneous coordinates - Line drawing -Clipping- viewing transformation- Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – CAD/CAM concepts –Types of production - Manufacturing models and Metrics.

UNIT 2	GEOMETRIC MODELING	9

Wireframe, surface, NURBS and solid modeling -applications and advantages. Creating primitive solids, sweeping solids, boolean operations. Extracting entities from a solid. Filleting of edges of solids. Boundary representation (B-rep) Constructive Solid Geometry (CSG) and Analytical Solid Modeling (ASM).

UNIT 3	CAD STANDARDS	9

Graphics Standards - Graphical Kernel System (GKS) - standards for exchange images Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

UNIT 4	FUNDAMENTAL OF CNC AND PART PROGRAMING	9

Introduction to NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools- Principle of operation CNC- Construction features including structure- Drives and CNC controllers- 2D and 3D machining on CNC- Introduction of Part Programming, types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros.

UNIT 5	CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (FMS)	9

Group Technology (GT), Part Families–Parts Classification and coding– Production flow Analysis– Cellular Manufacturing– Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS, digital manufacturing, introduction to lean manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon the completion of this course the students will be able to,	
CO1	Describe the product life cycle and understand the fundamentals of CAD/CAM.
CO2	Explain the representation of synthetic curves, surface modeling and solid modeling
CO3	Explain the various CAD standards and data exchange formats
CO4	Apply CNC principles for manufacturing of components
CO5	Apply CNC principles for manufacturing of components

REFERENCES

1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill PublishingCo.2007.
2. Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi,2000.
3. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
4. Latit Narayan, Mallikarjuna Rao, Sarcar, "Computer Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 2008.
5. Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management " Second Edition, Pearson Education, 1999.
6. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education -2003

COURSE CODE	COURSE NAME	L	T	P	C
191ME423	THERMAL ENGINEERING	3	0	0	3

(Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)

COURSE OBJECTIVES

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes
- To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems

UNIT 1	GAS AND STEAM POWER CYCLES	9

Air Standard Cycles - Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison – Rankine, reheat and regenerative cycle and combined cycles-Applications.

UNIT 2	INTERNAL COMBUSTION ENGINES	9

Classification - components and their function, valve timing diagram and port timing diagram – actual and theoretical p-V diagram of four stroke and two stroke engines, Simple and complete carburetor. MPFI, CRDi, Diesel pump and injector system, battery and magneto ignition System - principles of combustion and knocking in SI and CI Engines, lubrication and cooling systems, performance test and heat balance test calculations..

UNIT 3	STEAM NOZZLES AND TURBINES	9

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, Supersaturated flow. impulse turbine and reaction turbine principles, compounding, velocity diagram for simple and multi-stage turbines, speed regulations –governors.

UNIT 4	AIR COMPRESSOR	9

Classification and working principle of various types of compressors, work of compression with and without clearance, volumetric efficiency, isothermal efficiency and isentropic efficiency of reciprocating compressors, multistage air compressor and inter cooling –work of multistage air compressor, introduction to FRL unit.

UNIT 5	REFRIGERATION AND AIR CONDITIONING	9

Refrigerants - Vapour compression refrigeration cycle- super heat, sub cooling, COP, introduction to global warming potential, ozone depletion potential and effects, working principle of vapour absorption system – ammonia-water, Lithium bromide– water, vapour adsorption system, hybrid cooling system,

steam refrigeration system (Description only). Air conditioning system – Psychrometric system processes, types and working principles. - concept of RSHF, GSHF, ESHF- Cooling Load calculations, Energy saving potential.	
TOTAL: 45 PERIODS	
COURSE OUTCOMES: Upon the completion of this course the students will be able to,	
CO1	Apply thermodynamic concepts to different air standard cycles and steam power cycles to solve problems
CO2	Solve problems related to single stage and multistage air compressors
CO3	Explain the functioning and features of IC engines, its components and its auxiliaries
CO4	Calculate performance parameters of IC Engines
CO5	Explain the flow in gas turbines and solve problems

REFERENCES

1. Rajput. R. K., “Thermal Engineering” S.Chand Publishers, 2000
2. Ganesan.V.” Internal Combustion Engines” , Third Edition, Tata McGraw-Hill 2007
3. Arora.C.P, ”Refrigeration and Air Conditioning ,” Tata McGraw-Hill Publishers 1994
4. Sarkar, B.K, "Thermal Engineering” Tata McGraw-Hill Publishers, 2007
5. Rudramoorthy, R, “Thermal Engineering “,Tata McGraw-Hill, New Delhi,2003

COURSE CODE	COURSE NAME	L	T	P	C
191HS40B	INTERPERSONAL SKILLS LABORATORY	0	0	2	1

COURSE OBJECTIVES

- To equip students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
- Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities.
- Improve general and academic listening skills
- Make effective presentations.

UNIT 1: Listening as a key skill- its importance- speaking - give personal information - ask for personal information - express ability - enquire about ability - ask for clarification Improving pronunciation - pronunciation basics taking lecture notes - preparing to listen to a lecture - articulate a complete idea as opposed to producing fragmented utterances.

UNIT 2: Listen to a process information- give information, as part of a simple explanation – conversation starters: small talk - stressing syllables and speaking clearly - intonation patterns - compare and contrast information and ideas from multiple sources- converse with reasonable accuracy over a wide range of everyday topics.

UNIT 3: Lexical chunking for accuracy and fluency- factors influence fluency, deliver a five-minute informal talk - greet - respond to greetings - describe health and symptoms - invite and offer - accept – decline - take leave - listen for and follow the gist- listen for detail

UNIT 4: Being an active listener: giving verbal and non-verbal feedback - participating in a group discussion -summarizing academic readings and lectures conversational speech listening to and participating in conversations - persuade.

UNIT 5: Formal and informal talk - listen to follow and respond to explanations, directions and instructions in academic and business contexts - strategies for presentations and interactive communication - group/pair presentations - negotiate disagreement in group work.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

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

CO1	Listen and respond appropriately
CO2	Participate in group discussions

CO3	Make effective presentations
CO4	Participate confidently and appropriately in conversations both formal and informal

REFERENCES

1. Brooks, Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011.
2. Richards. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010
3. Bhatnagar, Nitin and Mamta Bhatnagar. Communicative English for Engineers and Professionals. Pearson: New Delhi, 2010.
4. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.
5. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014
6. Richards C. Jack. Person to Person (Starter). Oxford University Press: Oxford, 2006.
7. Vargo, Mari. Speak Now Level 4. Oxford University Press: Oxford, 2013.

COURSE CODE	COURSE NAME	L	T	P	C
191ME41A	STRENGTH OF MATERIALS LABARATORY	0	0	4	2

COURSE OBJECTIVES

- To study the mechanical properties of materials when subjected to different types of loading

LIST OF EXPERIMENTS

1. Tension test on a mild steel rod
2. Double shear test on Mild steel and Aluminium rods
3. Torsion test on mild steel rod
4. Impact test on metal specimen
5. Hardness test on metals - Brinnell and Rockwell Hardness Number
6. Deflection test on beams
7. Compression test on helical springs
8. Tempering- Improvement Mechanical properties Comparison (i) Unhardened specimen (ii) Quenched Specimen and (iii) Quenched and tempered specimen.
9. Microscopic Examination of (i) Hardened samples and (ii) Hardened and tempered samples.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Access the mechanical properties of the given specimen
CO2	Evaluate the strength of the material under working conditions

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Universal Tensile Testing machine with double 1 shear attachment – 40 Ton Capacity	1 No.
2	Torsion Testing Machine (60 NM Capacity)	1No.
3	Impact Testing Machine (300 J Capacity)	1 No.
4	Brinell Hardness Testing Machine	1 No.
5	Rockwell Hardness Testing Machine	1 No.
6	Spring Testing Machine for tensile and compressive loads (2500 N)	1 No.
7	Metallurgical Microscopes	3 Nos.
8	Muffle Furnace (800 C)	1 No.

COURSE CODE	COURSE NAME	L	T	P	C
191ME42A	C.A.D. / C.A.M. LABARATORY	0	0	4	2

COURSE OBJECTIVES

- To make the students understand and interpret drawings of machine components.
- To gain practical experience in handling 3D modeling software system.
- To gain practical knowledge of CNC programming
- To make the students understand the tool path verification and CNC code generation

LIST OF EXPERIMENTS

I. 3D GEOMETRIC MODELLING **30**

1. Introduction to 3D modeling software.
2. Sleeve & cotter joints
3. Gib & cotter joint.
4. Bush bearing.
5. Plummer block.
6. Safety valve.
7. Flange Coupling.
8. Universal Coupling.
9. Oldham's coupling.
10. Knuckle joint.
11. Piston and Connecting rod.
12. Screw jack.

II. Manual Part Programming. **30**

(i) Part Programming - CNC Machining Centre

a) Linear Cutting.

b) Circular cutting.

c) Cutter Radius Compensation.

d) Canned Cycle Operations.

(ii) Part Programming - CNC Turning Centre

a) Straight, Taper and Radius Turning.

b) Thread Cutting .

c) Rough and Finish Turning Cycle.

d) Drilling and Tapping Cycle. e) CL Data and Post process generation using CAM packages. f) Application of CAPP in Machining and Turning Centre.
TOTAL: 60 PERIODS

COURSE OUTCOMES:	
On successful completion of the course, students will be able to ,	
CO1	Model, assemble and draft the given drawing of machine component using standard software package
CO2	Write CNC code and simulate for manufacturing in the CNC machine specified

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Computer nodes or systems (High end CPU with at least 1GB main memory)	1 No.
2	Licensed CAD software (30 User)	1No.
3	FANUC CNC simulation software (15 user)	1 No.
4	Trainer CNC Milling machine	1 No.
5	Trainer CNC Lathe machine	1 No.
6	Laser Printer	1 No.
7	A3 Plotter	1 No.

COURSE CODE	COURSE NAME	L	T	P	C
191ME521	DESIGN OF MACHINE ELEMENTS	3	0	0	3

(Use of standard design data book permitted)

COURSE OBJECTIVES

- To familiarize the various steps involved in the Design Process
- To understand the principles 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 1	STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS	9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

UNIT 2	SHAFTS AND COUPLINGS	9

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings.

UNIT 3	TEMPORARY AND PERMANENT JOINTS	9

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

UNIT 4	ENERGY STORING ELEMENTS AND ENGINE COMPONENTS	9

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT 5	BEARINGS	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Analyze machine elements based on steady and variable stresses.
CO2	Design the shaft and coupling
CO3	Analyse temporary and permanent joint for given application
CO4	Design and analyse Energy Storing Elements and Engine Components
CO5	Design the Bearing element for desired applications

REFERENCES

1. Bhandari V, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co, 2010.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, 2008.
3. Sundararajamoorthy T. V. Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4 th Edition, Wiley, 2005
5. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill Book Co.(Schaum's Outline), 2010
6. Bernard Hamrock, Steven Schmid, Bo Jacobson, "Fundamentals of Machine Elements", 2nd Edition, Tata McGraw-Hill Book Co., 2006.
7. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
8. Ansel Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
9. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Prentice Hall, 2003.

COURSE CODE	COURSE NAME	L	T	P	C
191ME522	METROLOGY AND MEASUREMENTS	3	0	0	3

COURSE OBJECTIVES

- To provide knowledge on various Metrological equipments available to measure the dimension of the components. To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.

UNIT 1	BASICS OF METROLOGY	9

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

UNIT 2	LINEAR AND ANGULAR MEASUREMENTS	9

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT 3	ADVANCES IN METROLOGY	9

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

UNIT 4	FORM MEASUREMENT	9

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

UNIT 5	MEASUREMENT OF POWER, FLOW AND TEMPERATURE	9

Force, torque, power - mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Explain the difference between accuracy and precision and also understand the sources of error.
CO2	Elaborate on the instruments like screw gauge, vernier calliper, slip gage, bevel protractor and design limit gauges.
CO3	Explain the functioning of laser metrology instruments, co- ordinate Measuring Machine and Machine Vision systems.
CO4	Explain the methods of measuring straightness, flatness, surface roughness and various features of gears
CO5	Explain the methods of measuring force, torque, power, flow and temperature

REFERENCES

1. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005. 2. Jain R.K. "Engineering Metrology", Khanna Publishers, 2009.
2. Alan S. Morris, "The essence of Measurement", Prentice Hall of India 1996.
3. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2014.
4. Charles Reginald Shotbolt, "Metrology for Engineers", 5 th edition, Cengage Learning EMEA, 1990.
5. Donald Peckman, "Industrial Instrumentation", Wiley Eastern, 2004.
6. Raghavendra, Krishnamurthy "Engineering Metrology & Measurements", Oxford Univ. Press, 2013.

COURSE CODE	COURSE NAME	L	T	P	C
191ME523	DYNAMICS OF MACHINES	2	2	0	3

COURSE OBJECTIVES

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of Dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control.

UNIT 1	FORCE ANALYSIS	12

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses- Dynamics of Cam- follower mechanism

UNIT 2	BALANCING	12

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines – Balancing of linkages – Balancing machines-Field balancing of discs and rotors.

UNIT 3	FREE VIBRATION	12

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

UNIT 4	FORCED VIBRATION	12

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

UNIT 5	MECHANISM FOR CONTROL	12

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes – Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

	TOTAL: 60 PERIODS
COURSE OUTCOMES On successful completion of the course, students will be able to	
CO1	Describe and solve dynamic equilibrium in simple mechanisms
CO2	Construct graphical representation and find solution for partially balanced systems
CO3	Find solutions for free vibration systems
CO4	Find solution for forced vibration systems
CO5	Solve for critical speed conditions in controlling mechanisms & determine values of controlling forces

REFERENCES

1. D. B. Sayyad, "Dynamics of Machinery", McMillan Publishers India Ltd., Tech-Max Educational resources, 2011.
2. Rattan, S.S, "Theory of Machines", 4 th Edition, Tata McGraw-Hill, 2014.
3. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 4 th Edition, Oxford University Press, 2014.
4. Khurmi, R.S.,"Theory of Machines", 14th Edition, S Chand Publications, 2005.

COURSE CODE	COURSE NAME	L	T	P	C
191ME52A	METROLOGY AND MEASUREMENTS LABORATORY	0	0	4	2

COURSE OBJECTIVES

- To familiar with different measurement equipments and use of this industry for quality inspection

LIST OF EXPERIMENTS

1. Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge– using gauge blocks
2. Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge
3. Measurement of linear dimensions using Comparators
4. Measurement of angles using bevel protractor and sine bar
5. Measurement of screw thread parameters – Screw thread Micrometers and Three wire method (floating carriage micrometer)
6. Measurement of gear parameters – disc micrometers, gear tooth vernier caliper
7. Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM)
8. Programming of CNC Coordinate Measuring Machines for repeated measurements of identical components
9. Non-contact (Optical) measurement using Toolmaker's microscope / Profile projector and Video measurement system
10. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments
11. Machine tool metrology – Level tests using precision level; Testing of straightness of a machine tool guide way using Autocollimator, spindle tests
12. Measurement of force, torque and temperature

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Measure the gear tooth dimensions, angle using sine bar, straightness and flatness, thread parameters, temperature using thermocouple, force, displacement, torque and vibration
CO2	Calibrate the vernier, micrometer and slip gauges and setting up the comparator for the inspection

REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of Equipment	Quantity (R)
1.	Micrometer	5 No.
2.	Vernier Caliper	5 No.
3.	Vernier Height Gauge	2 No.
4.	Vernier depth Gauge	2 No.
5.	Slip Gauge Set	1 No.
6.	Gear Tooth Vernier	1 No.
7.	Sine Bar	1 No.
8.	Floating Carriage Micrometer	1 No.
9.	Profile Projector / Tool Makers Microscope	1 No.
10.	Parallel / counter flow heat exchanger apparatus	1 No.
11.	Mechanical / Electrical / Pneumatic Comparator	1 No.
12.	Autocollimator	1 No.
13.	Temperature Measuring Setup	1 No.
14.	Force Measuring Setup	1 No.
15.	Torque Measuring Setup	1 No.
16.	Coordinate measuring machine	1 No.
17.	Surface finish measuring equipment	1 No.
18.	Bore gauge	1 No.
19.	Telescope gauge	1 No.

COURSE CODE	COURSE NAME	L	T	P	C
191ME52B	KINEMATICS AND DYNAMICS LABORATORY	0	0	4	2

COURSE OBJECTIVES

- To supplement the principles learnt in kinematics and Dynamics of Machinery.
- To apply how certain measuring devices are used for dynamic testing.

LIST OF EXPERIMENTS

1. a) Study of gear parameters.

   b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.

2. a)Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.

   b) Kinematics of single and double universal joints.

3. a) Determination of Mass moment of inertia of Fly wheel and Axle system.

b)Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.

   c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.

4. Motorized gyroscope – Study of gyroscopic effect and couple.

5. Governor - Determination of range sensitivity and effort for Watts, Porter, Proell, and Governors.

6. Cams – Cam profile drawing, Motion curves and study of jump phenomenon

7. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification
   of Laws of springs – Damping coefficient determination. b) Multi degree freedom suspension system Determination of influence coefficient.

8. a) Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies. b) Vibration Absorber – Tuned vibration absorber.

9. Vibration of Equivalent Spring mass system – undamped and damped vibration.

10. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.

11. a) Balancing of rotating masses. (b) Balancing of reciprocating masses.

12. a) Transverse vibration of Free-Free beam – with and without concentrated masses.

    b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.

    c) Determination of transmissibility ratio using vibrating table.

	TOTAL: 60 PERIODS
COURSE OUTCOMES: On successful completion of the course, students will be able to	
CO1	Explain gear parameters, kinematics of mechanisms, gyroscopic effect and working of lab equipments
CO2	Determine mass moment of inertia of mechanical element, governor effort and range sensitivity, natural frequency and damping coefficient, torsional frequency, critical speeds of shafts, balancing mass of rotating and reciprocating masses, and transmissibility ratio

REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Sl.No.	Description of Equipment	Quantity (R)
1.	Cam follower setup	1 No.
2.	Motorised gyroscope	1 No.
3.	Governor apparatus - Watt, Porter, Proell and Hartnell governors	1 No.
4.	Whirling of shaft apparatus	1 No.
5.	Dynamic balancing machine	1 No.
6.	Two rotor vibration setup	1 No.
7.	Spring mass vibration system	1 No.
8.	Torsional Vibration of single rotor system setup	1 No.
9.	Gear Models	1 No.
10.	Kinematic Models to study various mechanisms	1 No.
11.	Turn table apparatus	1 No.
12.	Transverse vibration setup of cantilever	1 No.

COURSE CODE	COURSE NAME	L	T	P	C
191ME621	DESIGN OF TRANSMISSION SYSTEMS	3	0	0	3

(Use of standard Design data book permitted)

COURSE OBJECTIVES

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission
- To apply the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues

UNIT 1	DESIGN OF FLEXIBLE ELEMENTS	9

Design of flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

UNIT 2	SPUR GEARS AND PARALLEL AXIS HELICAL GEARS	9

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane Equivalent number of teeth-forces for helical gears.

UNIT 3	BEVEL, WORM AND CROSS HELICAL GEARS	9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT 4	GEAR BOXES	9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNIT 5	CLUTCHES AND BRAKES	9

Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches, Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

Total: 45 Periods

COURSE OUTCOMES:

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

CO1	Apply the concepts of design to belts, chains and rope drives
CO2	Apply the concepts of design to spur, helical gears
CO3	Apply the concepts of design to worm and bevel gears
CO4	Apply the concepts of design to gear boxes
CO5	Apply the concepts of design to brakes and clutches

REFERENCES

1. Bhandari V, "Design of Machine Elements", 4 th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engine Design", 8 th Edition, Tata McGraw-Hill, 2008.
3. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8 th Edition, Prentice Hall, 2003.
4. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
5. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
6. Robert C. Juvinall and Marshek, K.M., "Fundamentals of Machine Design", 4th Ed,Wiley,2005.

COURSE CODE	COURSE NAME	L	T	P	C
191ME622	HEAT AND MASS TRANSFER	3	0	0	3

COURSE OBJECTIVES

- To apply the mechanisms of heat transfer under steady and transient conditions
- To apply the concepts of heat transfer through extended surfaces
- To learn the thermal analysis and sizing of heat exchangers and to apply the basic concepts of mass transfer

UNIT 1	CONDUCTION	12

General Differential equation of Heat Conduction– Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts.

UNIT 2	CONVECTION	12

Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

UNIT 3	PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS	12

Nusselt's theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method.

UNIT 4	RADIATION	12

Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases

UNIT 5	MASS TRANSFER	12

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

Total: 60 Periods

COURSE OUTCOMES

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

CO1	Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems
CO2	Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems
CO3	Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems
CO4	Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems
CO5	Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications

REFERENCES

1. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2000.
2. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition 2015
3. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1998.
4. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998.
5. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002 4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
6. 6. R.C. Sachdeva, “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009.

COURSE CODE	COURSE NAME	L	T	P	C
191ME623	FINITE ELEMENT ANALYSIS	3	0	0	3

COURSE OBJECTIVES

- To introduce the concepts of mathematical modeling of engineering problems
- To appreciate the use of finite element methods to a range of engineering problems

UNIT 1	INTRODUCTION	9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT 2	ONE-DIMENSIONAL PROBLEMS	9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

UNIT 3	TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS	9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT 4	TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS	9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

UNIT 5	ISOPARAMETRIC FORMULATION	9

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software

Total: 45 Periods

COURSE OUTCOMES

On successful completion of the course, students will be able to	
CO1	Summarize the basics of finite element formulation
CO2	Apply finite element formulations to solve one dimensional Problems
CO3	Apply finite element formulations to solve two dimensional scalar Problems
CO4	Apply finite element method to solve two dimensional Vector problems
CO5	Apply finite element method to solve problems on isoparametric element and dynamic Problems.

REFERENCES

1. Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2005.
2. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
3. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005
4. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice Hall College Div, 1990.
5. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002.
6. Rao, S.S., “The Finite Element Method in Engineering”, 3rd Edition, Butterworth Heinemann, 2004.
7. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.

COURSE CODE	COURSE NAME	L	T	P	C
191ME62A	FINITE ELEMENT METHOD LABORATORY	0	0	4	2

COURSE OBJECTIVES

- To give exposure to software tools needed to analyze engineering problems
- To expose the students to different applications analysis tools

LIST OF EXPERIMENTS

1. Force and Stress analysis using link elements in Trusses
2. Force and Stress analysis using link elements in cables
3. Stress and deflection analysis in beams with simply support conditions
4. Stress and deflection analysis in beams with fixed support conditions
5. Stress and deflection analysis in beams with overhanging support conditions
6. Stress analysis of flat plates and simple shells
7. Stress analysis of axi – symmetric components.
8. Thermal stress and heat transfer analysis of plates.
9. Thermal stress analysis of cylindrical shells.
10. Vibration analysis of spring-mass systems.
11. Model analysis of Beams.
12. Harmonic analysis of simple systems.
13. Transient and spectrum analysis of simple systems.
14. Spectrum analysis of simple systems.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1	Model experiments to meet real world system
CO2	Analyse experiments and evaluate the performance

REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Sl.No.	Description of Equipment	Quantity
1.	Computer Work Station	15 No.
2.	Color Desk Jet Printer	1 No.
3.	Suitable Software for Finite Element analysis	25 licenses

COURSE CODE	COURSE NAME	L	T	P	C
191ME62B	THERMAL ENGINEERING LABORATORY	0	0	4	2

COURSE OBJECTIVES

- To Study the characteristics of fuels/Lubricates used in IC Engines
- To study the value timing diagram and performance of IC Engines
- • To study the Performance of steam generator/ turbine
- • To study the heat transfer phenomena predict the relevant coefficient using implementation
- • To study the performance of refrigeration cycle / component

LIST OF EXPERIMENTS

1. Experimental study on valve timing diagram in 4-stroke engine and port timing diagram in 2 – stroke engine.
2. Experimental study on port timing diagram in 2-stroke engine cut model.
3. Determination of Flash Point and Fire Point of various fuels / lubricants.
4. Performance test on constant speed 4-stroke diesel engine.
5. Variable speed test on multi-cylinder diesel engine.
6. Heat balance test on 4-stroke diesel engine.
7. Performance test on high pressure two stage reciprocating air compressor.
8. Performance testing of boiler and steam turbine.
9. IC engine performance evaluation using PC interface.
10. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
11. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
12. Determination of heat transfer coefficient under forced convection from a tube.
13. Determination of Thermal conductivity of insulating material Using composite wall and insulating powder.
14. Heat transfer from pin-fin apparatus (natural & forced convection modes).
15. Effectiveness of Parallel / counter flow heat exchanger.
16. Experiment of heating, ventilation and air conditioning unit.
17. Experiment on refrigeration tutor.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1	Model experiments to meet real world system
CO2	Analyse experiments and evaluate the performance

REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Sl.No.	Description of Equipment	Quantity
1.	I.C Engine – 2 stroke and 4 stroke model	1 No. each
2.	Apparatus for Flash and Fire Point	1 No.
3.	4-stroke Diesel Engine with mechanical loading	1 No.
4.	4-stroke Diesel Engine with hydraulic loading	1 No.
5.	4-stroke Diesel Engine with electrical loading	1 No.
6.	Multi-cylinder Petrol Engine	1 No.
7.	Single cylinder Petrol Engine	1 No.
8.	Data Acquisition system with any one of the above engines	1 No.
9.	Steam Boiler with turbine setup	1 No.
10.	Guarded plate apparatus	1 No.
11.	Lagged pipe apparatus	1 No.
12.	Natural convection-vertical cylinder apparatus	1 No.
13.	Forced convection inside tube apparatus	1 No.
14.	Composite wall apparatus	1 No.
15.	Thermal conductivity of insulating powder apparatus	1 No.
16.	Pin-fin apparatus	1 No.
17.	Stefan-Boltzmann apparatus	1 No.
18.	Emissivity measurement apparatus	1 No.
19.	Parallel/counter flow heat exchanger apparatus	1 No.
20.	Single/two stage reciprocating air compressor	1 No.
21.	Refrigeration test rig	1 No.
22.	Air-conditioning test rig	1 No.

COURSE CODE	COURSE NAME	L	T	P	C
191HS701	PRINCIPLES OF MANAGEMENT	3	0	0	3

COURSE OBJECTIVES

- To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization

UNIT 1	INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	9

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers - managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management.

UNIT 2	MANAGEMENT BY OBJECTIVES	9

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT 3	COORDINATING ACTIVITIES AND RESOURCES	9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management , Career planning and management.

UNIT 4	LEADERSHIP AND COMMUNIVATION	9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

UNIT 5	MONITORING AND EVALUATING ACTIVITIES	9

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting.

Total: 45 Periods

COURSE OUTCOMES:

On successful completion of the course, students will be able to	
CO1	Understanding of managerial functions like planning, organizing, staffing, leading & controlling
CO2	Basic knowledge on international aspect of management
CO3	Apply planning in the business process
CO4	Apply the concepts of organizing and directing the business process
CO5	Apply various means of controlling in a company to the benefit of organization

REFERENCES

1. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.
2. Stephen P. Robbins & Mary Coulter, "Management", Prentice Hall (India) Pvt. Ltd., 10th Edition, 2009.
3. Harold Koontz & Heinz Weihrich, "Essentials of Management", Tata McGraw Hill, 1998.
4. Robert Kreitner & Mamata Mohapatra, "Management", Biztantra, 2008.
5. Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management", 7thEdition, Pearson Education, 2011.
6. Tripathy PC & Reddy PN, "Principles of Management", Tata McGraw Hill, 1999.

COURSE CODE	COURSE NAME	L	T	P	C
191ME721	POWER PLANT ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To provide an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance.

UNIT 1	COAL BASED THERMAL POWER PLANTS	9

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems. Load curve for power plants- Clean coal technology

UNIT 2	DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS	9

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems. Peak load power plants

UNIT 3	NUCLEAR POWER PLANTS	9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants. Nuclear waste handling methods.

UNIT 4	RENEWABLE ENERGY BASED POWER PLANTS	9

Principle, Construction and working of Wind, Tidal, SolarPhoto Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems. Medium and small sized power plants for individual's use.

UNIT 5	ENERGY ECONOMICS& ENVIRONMENTAL IMPACTS OF POWER PLANTS	9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants. Standards for power plants emission - Carbon emission control techniques.

Total: 45 Periods

COURSE OUTCOMES	
Upon the completion of this course the students will be able to,	
CO1	Explain the layout, construction and working of the components inside a thermal power plant.
CO2	Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
CO3	Explain the layout, construction and working of the components inside nuclear power plants.
CO4	Explain the layout, construction and working of the components inside Renewable energy power plants.
CO5	Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.

REFERENCES

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008.
2. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
3. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
4. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.

COURSE CODE	COURSE NAME	L	T	P	C
191ME531	AUTOMOBILE ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To understand the construction and working principle of various parts of an automobile.
- To have the knowledge for assembling and dismantling of engine parts and transmission system

UNIT 1	VEHICLE STRUCTURE AND ENGINES	9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines –components-functions and materials, variable valve timing (VVT).

UNIT 2	ENGINE AUXILIARY SYSTEMS	9

Electronically controlled gasoline injection system for SI engines, electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT 3	TRANSMISSION SYSTEMS	9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT 4	STEERING, BRAKES AND SUSPENSION SYSTEMS	9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

UNIT 5	ALTERNATIVE ENERGY SOURCES	9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of the course, students will be able to	
CO1	Explain the various parts of the automobile and their functions and materials.
CO2	Discuss the engine auxiliary systems and engine emission control
CO3	Distinguish the working of different types of transmission systems
CO4	Explain the Steering, Brakes and Suspension Systems.
CO5	Predict possible alternate sources of energy for IC Engines

REFERENCES

1. Jain K.K. and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.
2. Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.
3. Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2012.
4. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.
5. Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.
6. Martin W, Stockel and Martin T Stockle, "Automotive Mechanics Fundamentals," The Good heart - Will Cox Company Inc, USA, 1978.
7. Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers, 1989.

COURSE CODE	COURSE NAME	L	T	P	C
191ME532	BUSINESS ANALYTICS	3	0	0	3

COURSE OBJECTIVES

- To introduce the basic concept of machine learning, the application of business analysis, and expose to the basic concepts of Data Science Project Life Cycle.

UNIT 1	INTRODUCTION TO BUSINESS ANALYTICS	9

Historical Overview of data analysis, Data Scientist vs. Data Engineer vs. Business Analyst, Career in Business Analytics, What is data science, Why Data Science, Applications for data science, Data Scientists Roles and Responsibility

UNIT 2	DATAMANAGEMENT	9

Data Collection, Data Management, Big Data Management, Organization/sources of data, Importance of data quality, Dealing with missing or incomplete data, Data Visualization, Data Classification, Business Requirement, Data Acquisition, Data Preparation, Hypothesis and Modeling, Evaluation and Interpretation, Deployment, Operations, Optimization.

UNIT 3	INTRODUCTION TO DATA MINING	9

The origins of Data Mining, Data Mining Tasks, OLAP and Multidimensional data analysis, Basic concept of Association Analysis and Cluster Analysis.

UNIT 4	INTRODUCTION TO MACHINE LEARNING	9

History and Evolution, AI Evolution, Statistics Vs Data Mining Vs, Data Analytics Vs, Data Science, Supervised Learning, Unsupervised Learning, Reinforcement Learning, Frameworks for building Machine Learning Systems.

UNIT 5	APPLICATION OF BUSINESS ANALYSIS	9

Retail Analytics, Marketing Analytics, Financial Analytics, Healthcare Analytics, Supply Chain Analytics

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Understand the basics of business analysis and Data Science
CO2	Understand data management and handling and Data Science Project Life Cycle

CO3	Understand the data mining concept and its techniques
CO4	Understand and Analyzing machine learning concept
CO5	Understand the application of business analysis in different domain

REFERENCES

1. Tan, P.N., Steinbach, M. and Kumar, V., "Introduction to data mining", Pearson Education India. 2016
2. Koole, G. "An Introduction to Business Analytics", Lulu.com, 2019
3. Pochiraju, B. and Seshadri, S., "Essentials of Business Analytics: An Introduction to the Methodology and Its Applications", Springer. 2019
4. Müller, A.C. and Guido, S.,." Introduction to machine learning with Python: a guide for data scientists". O'Reilly Media, Inc., 2016
5. Mayer-Schönberger, V. and Cukier, K.,. Big data: A revolution that will transform how we live, work, and think. Houghton Mifflin Harcourt. 2013

COURSE CODE	COURSE NAME	L	T	P	C
191ME533	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3

COURSE OBJECTIVES

- To introduce the basic concepts of Computer Integrated Manufacturing (CIM).
- To provide knowledge on Group Technology and Computer Aided Process Planning
- To impart knowledge on Shop Floor Control and Flexible Manufacturing Systems.
- To learn the various CIM implementation and data communication techniques.
- To provide knowledge on the concept of Manufacturing automation protocol, Technical
- Office protocol and database terminology..

UNIT 1	INTRODUCTION	9

The changing manufacturing and management scene, External communication, Islands of automation and software, dedicated and open systems, manufacturing automation protocol, introduction to CAD/CAM integration.

UNIT 2	GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING	9

Classification and coding - DCLASS, MICLASS and OPITZ coding systems. Facility design using G.T. - Benefits of G.T - cellular manufacturing. Process planning, role of process planning in CAD/CAM integration- approaches to computer aided process planning- variant approach and generative approaches.

UNIT 3	SHOP FLOOR CONTROL AND FMS	9

Shop floor control phases -factory data collection system -automatic identification methods- Bar code technology - automated data collection system. FMS- components of FMS- types -FMS workstation material handling and storage systems- FMS layout-computer control systems-application and benefits

UNIT 4	CIM IMPLEMENTATION AND DATA COMMUNICATION	9

System modelling tools- ICAM definition (IDEF) models, activity cycle diagram, CIM open system architecture (CIMOSA) - manufacturing enterprise wheel- CIM architecture- Product data management, implementation-software. Communication fundamentals- local area networks (LAN) -topology -LAN implementations - network management and installations.

UNIT 5	OPEN SYSTEM AND DATABASE FOR CIM	9

Open systems-open system inter-connection - manufacturing automation protocol and technical office protocol-(MAP/TOP).Development of databases -database terminology architecture of database

systems- data modeling and data associations -relational data bases – database operators - advantages of data base and relational database

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Assess CAD/CAM integration for changing manufacturing and management scene
CO2	Construct a machine cell using the concepts of Group Technology and Computer Aided Proces Planning
CO3	Select the suitable material handling and storage system for Flexible Manufacturing Systems
CO4	Choose the suitable CIM implementation and data communication techniques
CO5	Use various protocols and database terminology in CIM

REFERENCES

1. Mikell P Groover, Automation of production systems and computer integrated manufacturing, Pearson Education, United States of America, 2008.
2. Lee Kunwoo, CAD,CAM,CAE systems, Addison Wesley, United States of America, 1999.
3. Kant Vajpayee S, Principles of Computer Integrated Manufacturing, Prentice Hall, New Delhi, 2003.
4. Radhakrishnan P, Subramanyan S and Raju V, CAD,CAM,CIM, Second Edition New Age International Pvt. Ltd, New Delhi, 2000.

COURSE CODE	COURSE NAME	L	T	P	C
191ME535	FUNDAMENTALS OF NANO SCIENCE	3	0	0	3

COURSE OBJECTIVES

- To learn about basis of nanomaterial science, preparation method, types and application

UNIT 1	INTRODUCTION	9

Nano scale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thin films multi layered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT 2	GENERAL METHODS OF PREPARATION	9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT 3	NANOMATERIALS	9

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays-functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT 4	CHARACTERIZATION TECHNIQUES	9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT 5	APPLICATIONS OF NANOSCIENCE	9

NanoInfoTech- Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, students will be able to	
CO1	Explain about the science of nano materials
CO2	Apply the fundamentals of Nano-Science in the preparation of nano materials
CO3	Explain characteristics of Nano-material
CO4	Explain characterisation techniques of Nano-material
CO5	Explain characteristics of Nano-science

REFERENCES

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, "Nanoscale Characterization of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.
3. G Timp, "Nanotechnology", AIP press/Springer, 1999.
4. Akhlesh Lakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

COURSE CODE	COURSE NAME	L	T	P	C
191ME534	ENTREPRENEURSHIP DEVELOPMENT	3	0	0	3

COURSE OBJECTIVES

- To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.

UNIT 1	ENTREPRENEURSHIP	9

To Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur, Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth

UNIT 2	MOTIVATION	9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT 3	BUSINESS	9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT 4	FINANCING AND ACCOUNTING	9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT 5	SUPPORT TO ENTREPRENEURS	9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Explain the fundamental concepts of entrepreneurship

CO2	Elaborate in detail about achievement Motivation Training
CO3	Explain about the steps involved in setting up a Business
CO4	Elaborate in detail about Finance related aspects of entrepreneurship
CO5	Explain about the different support to entrepreneurs to run business successfully

REFERENCES

1. Khanka. S.S., “Entrepreneurial Development” S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.
2. Donald F Kuratko, “Entreprenuership – Theory, Process and Practice”, 9th Edition, Cengage Learning, 2014.
3. Hisrich R D, Peters M P, “Entrepreneurship” 8th Edition, Tata McGraw-Hill, 2013.
4. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis” 2nd Edition Dream tech, 2005.
5. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.EDII “Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development”, Institute of India, Ahmadabad, 1986.

COURSE CODE	COURSE NAME	L	T	P	C
191ME630	GAS DYNAMICS AND JET PROPULSION	3	0	0	3

(Use of standard Gas tables data book is permitted)

COURSE OBJECTIVES

- To understand the basic difference between incompressible and compressible flow and gain knowledge on compressible flow through ducts, jet propulsion

UNIT 1	FUNDAMENTALS OF COMPRESSIBLE FLOW	9

Ideal gas relationship, The adiabatic energy equation, Mach number and its significance, Mach waves, Mach cone and Mach angle, static and stagnation states, relationship between stagnation temperature, pressure, density and enthalpy in terms of Mach number, stagnation velocity of sound, reference speeds, various regions of flow, Effect of Mach number on compressibility, Area velocity relationship.

UNIT 2	ONE DIMENSIONAL ISENTROPIC FLOW	9

General features of isentropic flow, performance curve, Comparison of adiabatic and isentropic process, One dimensional isentropic flow in ducts of varying cross-section- nozzles and diffusers, operation of nozzles under varying pressure ratio, mass flow rate in nozzles, critical properties and choking, area ratio as function of Mach number, Impulse function, non-dimensional mass flow rate in terms of pressure ratio, area ratio and Mach number, Working charts and gas tables, Application of Isentropic flow.

UNIT 3	NORMAL SHOCK WAVES	9

Development of shock wave, Thickness of shock wave, governing equations, Strength of shock waves, Prandtl-Mayer relation, Rankine-Hugoniot relation, Mach number in the downstream of normal shock, variation of flow parameters across the normal shock, normal shock in Fanno and Rayleigh flows, impossibility of a rarefaction shock, supersonic diffusers, supersonic pitot tube.

UNIT 4	FLOW IN CONSTANT AREA DUCT	9

Fanno curve and Fanno flow equations, solution of Fanno flow equations, variation of Mach no. with duct length, isothermal flow in constant area duct with friction, Experimental friction coefficients, Simple heating relation of a perfect gas, Rayleigh curve and Rayleigh flow equations, variations of flow properties, maximum heat transfer.

UNIT 5	JET PROPULSION	9

Introduction to Aircraft Jet Propulsion, Jet Engine Cycles - Thermodynamic Analysis of real cycles. Compressors and Turbines, Combustion Systems, Intakes and Propelling Nozzles, Aircraft Engine Installed Performance, Sizing & Matching. Ramjets, Scramjets and Pulse jets.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Differentiate between incompressible and compressible flow
CO2	Apply the concept of compressible flows in variable area ducts
CO3	Examine the effect of compression and expansion waves in compressible flow
CO4	Apply the concept of compressible flows in constant area ducts
CO5	Use the concept of gas dynamics in Jet Propulsion

REFERENCES

1. S. M. Yahya, "Fundamental of Compressible flow", New age international Publication, Delhi, 2005.
2. P. Balachandran, "Fundamentals of compressible fluid dynamics", PHI Learning, New Delhi, 2006.
3. Ascher H. Shapiro, "The dynamics and thermodynamics of Compressible fluid flow", Volume-I, , the Ronald Press Company, New York.,1954.
4. E. Rathakrishnan, "Gas Dynamics" , PHI Learning Pvt. Ltd, 2013.
5. P. Murugaperumal, Gas Dynamics and Jet Propulsion-, Scitech Publication, Chennai, 2005.
6. John D. Anderson," Modern Compressible Flow: With Historical Perspective" , McGraw-Hill Higher Education, 1999.

COURSE CODE	COURSE NAME	L	T	P	C
191ME631	HYDRAULICS AND PNEUMATICS	3	0	0	3

COURSE OBJECTIVES

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students insights of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

UNIT 1	FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS	9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

UNIT 2	HYDRAULIC ACTUATORS AND CONTROL COMPONENTS	9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

UNIT 3	HYDRAULIC CIRCUITS AND SYSTEMS	9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT 4	PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS	9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

UNIT 5	TROUBLE SHOOTING AND APPLICATIONS	9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Explain the Fluid power and operation of different types of pumps
CO2	Summarize the features and functions of Hydraulic motors, actuators and flow control valves
CO3	Explain the different types of hydraulic circuits and systems
CO4	Explain the working of different pneumatic circuits and systems
CO5	Summarize the various trouble shooting methods and applications of fluid power systems

REFERENCES

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGrawHill, 2001.
3. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
4. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.

COURSE CODE	COURSE NAME	L	T	P	C
191ME632	INTELLECTUAL PROPERTY RIGHTS	3	0	0	3

COURSE OBJECTIVES

- To gain an idea about Intellectual Property Rights, registration and its enforcement

UNIT 1	INTRODUCTION	9

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT 2	REGISTRATION OF IPRs	9

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT 3	AGREEMENTS AND LEGISLATIONS	9

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT 4	DIGITAL PRODUCTS AND LAW	9

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT 5	ENFORCEMENT OF IPRs	9

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Maintainintellectual property portfolio to enhance the value of the firm
CO2	Explain the procedures for registration of intellectual property rights
CO3	Explain the procedures **for** agreements and legislations for intellectual property rights

CO4	Explain the procedures for digital products and law in intellectual property rights
CO5	Explain the procedures for enforcementof IPRs

REFERENCES

1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India Pvt Ltd, 2012.
2. S. V. Satakar, Intellectual Property Rights and Copy Rights, EssEss Publications, New Delhi, 2002
3. Deborah E. Bouchoux, Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, Cengage Learning, Third Edition, 2012.
4. Prabuddha Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, McGraw Hill Education, 2011.
5. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

COURSE CODE	COURSE NAME	L	T	P	C
191ME633	PROFESSIONAL ETHICS IN ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To enable the students to create an awareness on Engineering Ethics and Human Values to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT 1	HUMAN VALUES	9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT 2	ENGINEERING ETHICS	9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT 3	ENGINEERING AS SOCIAL EXPERIMENTATION	9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT 4	SAFETY, RESPONSIBILITIES AND RIGHTS	9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT 5	GLOBAL ISSUES	9

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Apply engineering ethics in society related problems
CO2	Discuss the ethical issues related to engineering
CO3	Relate the responsibilities and rights in the society
CO4	Explain the safety, responsibilities and rights
CO5	Discuss global issues related to ethical way of functioning as engineers

REFERENCES

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
3. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
4. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
5. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
6. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
7. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" McGraw Hill education, India Pvt. Ltd., New Delhi, 2013.

COURSE CODE	COURSE NAME	L	T	P	C
191ME634	WELDING TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES

- To understand the basics of welding and to know about the various types of welding processes .

UNIT 1	GASANDARC WELDINGPROCESSES	9

Fundamental principles–air acetylene welding, oxy acetylene welding, carbon arc welding, shielded metal arc welding, Submerged arc welding, TIG & MIG welding, plasma arc welding and electro slag welding processes -advantages, limitations and applications.

UNIT 2	RESISTANCE WELDINGPROCESSES	9

Spot welding, seam welding, projection welding, resistance butt welding, flash butt welding, percussion welding and high frequency resistance welding processes- advantages, limitations and applications.

UNIT 3	SOLID STATE WELDINGPROCESSES	9

Cold welding, diffusion bonding, Explosive welding, ultrasonic welding, Friction welding, Forge welding, roll welding and hot pressure welding processes- advantages, limitations and applications.

UNIT 4	OTHER WELDINGPROCESSES	9

Thermit welding, atomic hydrogen welding, electron beam welding, Laser beam welding, Friction stir welding, Under water welding, welding automation in aerospace, nuclear and surface transport vehicles

UNIT 5	DESIGNOFWELD JOINTS,WELDABILITYANDTESTINGOF WELDMENTS	9

Various weld joint designs – welding defects– causes and remedies-weldability of aluminium, copper, and stainless steels. Destructive and non destructive testing of weldments.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Applytheconstructionand workingprinciples of gasand arcwelding process
CO2	Applytheconstructionand workingprinciples ofresistance weldingprocess

CO3	Apply the construction and working principles of various solid state welding process
CO4	Apply the construction and working principles of various special welding processes
CO5	Apply the concepts on weld joint design, weldability and testing of weldments

REFERENCES

1. Little, R.L., "Welding and welding Technology",Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
2. ParmerR.S.,"WeldingEngineeringandTechnology",1sty Edition, Khanna Publishers,New Delhi,2008.
3. Parmer R.S., "Welding Processes and Technology", Khanna Publishers,NewDelhi,1992.
4. AWS-Welding HandBook.8thEdition. Vol-2. "Welding Process"
5. Christopher Davis."Laser Welding- Practical Guide". Jaico Publishing House.
6. DavisA.C.,"TheScienceandPracticeofWelding",CambridgeUniversity Press,Cambridge, 1993
7. NadkarniS.V. "ModernArcWeldingTechnology", OxfordIBH Publishers,1stEdition,2005.
8. SchwartzM.M."MetalsJoiningManual".McGrawHill Books, 1979.
9. Tylecote R.F. "TheSolid PhaseWeldingofMetals". EdwardArnold PublishersLtd. London

COURSE CODE	COURSE NAME	L	T	P	C
191ME635	REFRIGERATION AND AIR CONDITIONING	3	0	0	3

COURSE OBJECTIVES

- To Apply the underlying principles of operations in different Refrigeration & Air conditioning systems and components
- To provide knowledge on design aspects of Refrigeration & Air conditioning systems

UNIT 1	INTRODUCTION	9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT 2	VAPOUR COMPRESSION REFRIGERATION SYSTEM	9

Vapor compression cycle - p-h and T-s diagrams - deviations from theoretical cycle – sub cooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system - low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT 3	OTHER REFRIGERATION SYSTEMS	9

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems.

UNIT 4	PSYCHROMETRIC PROPERTIES AND PROCESSES	9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT 5	AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION	9

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
On successful completion of the course, students will be able to	
CO1	Explain the basic concepts of Refrigeration
CO2	Explain the Vapor compression Refrigeration systems and to solve problems
CO3	Discuss the various types of Refrigeration systems
CO4	Calculate the psychrometric properties and its use in psychrometric processes
CO5	Explain the concepts of Air conditioning and to solve problems

REFERENCES

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010.
2. Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007.
3. Roy J. Dossat, "Principles of Refrigeration", 4 th edition, Pearson Education Asia, 2009.
4. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.
5. ASHRAE Hand book, Fundamentals, 2010.

COURSE CODE	COURSE NAME	L	T	P	C
191ME636	RENEWABLE SOURCES OF ENERGY	3	0	0	3

COURSE OBJECTIVES

- At the end of the course, the students are expected to identify the new methodologies / technologies for effective utilization of renewable energy sources.

UNIT 1	INTRODUCTION	9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in TamilNadu, India and around the World – Potentials - Achievements / Applications – Economics of renewable energy systems.

UNIT 2	SOLAR ENERGY	9

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

UNIT 3	WIND ENERGY	9

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects

UNIT 4	BIO - ENERGY	9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Biomass Applications

UNIT 5	OTHER RENEWABLE ENERGY SOURCES	9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage - Fuel Cell Systems – Hybrid Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Discuss the importance and Economics of renewable Energy

CO2	Discuss the method of power generation from Solar Energy
CO3	Discuss the method of power generation from Wind Energy
CO4	Explain the method of power generation from Bio Energy
CO5	Explain the Tidal energy, Wave Energy, OTEC, Hydro energy, Geothermal Energy, Fuel Cells and Hybrid Systems

REFERENCES

1. Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.
2. Twidell, J.W. & Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 2006.
3. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2015.
4. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2017
5. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
6. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012. 5. Johnson Gary, L. "Wind Energy Systems", Prentice Hall, New York, 1985

COURSE CODE	COURSE NAME	L	T	P	C
191ME637	SYSTEMS ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To introduce system engineering concepts to design the manufacturing system for optimum utilization of source for effective functioning

UNIT 1	INTRODUCTION	9

Definitions of Systems Engineering, Systems Engineering Knowledge, Life cycles, Life-cycle phases, logical steps of systems engineering, Frame works for systems engineering.

UNIT 2	SYSTEMS ENGINEERING PROCESSES	9

Formulation of issues with a case study, Value system design, Functional analysis, Business Process Reengineering, Quality function deployment, System synthesis, Approaches for generation of alternatives.

UNIT 3	ANALYSIS OF ALTERNATIVES- I	9

Cross-impact analysis, Structural modelling tools, System Dynamics models with case studies, Economic models: present value analysis – NPV, Benefits and costs over time, ROI, IRR; Work and Cost breakdown structure.

UNIT 4	ANALYSIS OF ALTERNATIVES–II	9

Reliability, Availability, Maintainability, and Supportability models; Stochastic networks and Markov models, Queuing network optimization, Time series and Regression models, Evaluation of large scale models.

UNIT 5	DECISION ASSESSMENT	9

Decision assessment types, Five types of decision assessment efforts, Utility theory, Group decision making and Voting approaches, Social welfare function; Systems Engineering methods for Systems Engineering Management

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Explain in detail about core principles of Systems Engineering

CO2	Describe different Systems Engineering processes
CO3	Perform analysis of alternatives in Systems Engineering for dynamics models
CO4	Perform analysis of alternatives in Systems Engineering for large scale models
CO5	Describe the different ways for decision assessment for designing effective system

REFERENCES

1. George A Hazelrigg “Systems Engineering: An Approach to Information-Based Design”, Prentice Hall, 1996.
2. Benjamin A and Walter J Fabrycky “Systems Engineering and Analysis”, Prentice Hall, 1998.
3. Alexander Kossiakoff and William N Sweet “Systems Engineering Principles and Practice”, Wiley Series in Systems Engineering and Management, 2011.
4. Charles S Wasson, “System Engineering Analysis, Design, and Development: Concepts, Principles, and Practices”, Wiley Series in Systems Engineering and Management, 2005.
5. Ralph M. Stair, George Walter Reynolds, Thomas Chesney, “Principles of Business Information Systems”, Cengage Learning, 2008.

COURSE CODE	COURSE NAME	L	T	P	C
191ME638	TOTAL QUALITY MANAGEMENT	3	0	0	3

COURSE OBJECTIVES

- To learn concepts, dimension quality and philosophies of TQM
- To study the TQM principles and its strategies
- To learn the seven tools of statistical quality and management
- To impart knowledge on TQM tools for continuous improvement
- To introduce international quality management systems

UNIT 1	INTRODUCTION	9

Definition of Quality - Dimensions of Quality - Quality Planning - Quality costs – Analysis Techniques for Quality Costs - Basic concepts of Total Quality Management - Historical Review - Quality Statements - Strategic Planning, Deming Philosophy - Crosby philosophy – Continuous Process Improvement - Juran Trilogy, PDSA Cycle, 5S, Kaizen - Obstacles to TQM Implementation.

UNIT 2	TQM PRINCIPLES	9

Principles of TQM, Leadership Concepts, Role of Senior Management, Quality Council, Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits - Supplier Partnership - Partnering, Sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures.

UNIT 3	STATISTICAL PROCESS CONTROL (SPC)	9

The seven tools of quality - Statistical Fundamentals - Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables X bar and R chart and attributes P, nP, C, and u charts, Industrial Examples, Process capability, Concept of six sigma - New seven Management tools.

UNIT 4	TQM TOOLS	9

Benchmarking, Quality Function Deployment (QFD) - House of Quality, QFD Process, and Benefits - Taguchi Quality Loss Function - Total Productive Maintenance (TPM), FMEA - Stages of FMEA, Case studies

UNIT 5	QUALITY SYSTEMS	9

Need for ISO 9000 and Other Quality Systems - Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 9000:2015, ISO 9001:2015 and ISO 9004:2018, TS 16949, ISO 14000, ISO 50001 - Concept, Requirements and Benefits

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Use the concepts, dimension of quality and philosophies of TQM
CO2	Apply the principles of TQM and its strategies in industries
CO3	Apply the statistical quality tools and seven management tools
CO4	Choose the suitable TQM tools for continuous improvement
CO5	Use the concept of QMS, EMS and EnMS in industries

REFERENCES

1. Dale H.Bester filed, Total Quality Management, Pearson Education Inc., New Delhi, 2003
2. N.Gupta and B.Valarmathi, Total Quality Management, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2009
3. James R.Evans and William M.Lidsay, The Management and Control of Quality, 2002
4. Dr.S.Kumar, Total Quality Management, Laxmi Publications Ltd. New Delhi, 2006
5. P.N.Muherjee, Total Quality Management, Prentice Hall of India, New Delhi, 2006

COURSE CODE	COURSE NAME	L	T	P	C
191ME639	UNCONVENTIONAL MACHINING PROCESSES	3	0	0	3

COURSE OBJECTIVES

- To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications

UNIT 1	INTRODUCTION	6

Unconventional machining Process – Need – classification – Brief overview.

UNIT 2	MECHANICAL ENERGY BASED PROCESSES	9

Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining - Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR- Applications.

UNIT 3	ELECTRICAL ENERGY BASED PROCESSES	9

Electric Discharge Machining (EDM) - working Principle-equipment's-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications.

UNIT 4	CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES	11

Chemical machining and Electro-Chemical machining (CHM and ECM)-Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications. Principles of ECM- equipments-Surface Roughness and MRR Electrical circuit-Process Parameters-ECG and ECH - Applications.

UNIT 5	THERMAL ENERGY BASED PROCESSES	10

Laser Beam machining and drilling (LBM), plasma Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques – Applications.

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Apply principles of unconventional machining in to practice
CO2	Analyze various mechanical energy based unconventional machining processes
CO3	Analyze various electrical energy based unconventional machining processes
CO4	Analyze various chemical and electro-chemical energy based unconventional machining processes

CO5	Analyze various thermal energy based unconventional machining processes

REFERENCES

1. Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2007 2. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi, 2007.
2. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987.
3. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, 1998.
4. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, "Material and Processes in Manufacturing" Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi, 2001.

COURSE CODE	COURSE NAME	L	T	P	C
191ME731	COMPOSITE MATERIALS AND MECHANICS	3	0	0	3

COURSE OBJECTIVES

- To make the students to understand different processing methods, issues, properties and testing methods of different composite materials.
- To provide the benefits gained when combining different materials into a composite.

UNIT 1	POLYMER MATRIX COMPOSITES	9

Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings – woven fabrics – non woven random mats – various types of fibres. PMC processes – hand layup processes – spray up processes – compression moulding – reinforced reaction injection moulding – resin transfer moulding – Pultrusion – Filament winding – Injection moulding, Applications of PMC in aerospace, automotive industries

UNIT 2	METAL MATRIX COMPOSITES	9

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries

UNIT 3	CERAMIC MATRIX COMPOSITES	9

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics - need for CMC – ceramic matrix - various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – aluminum oxide – silicon nitride – reinforcements – particles- fibres -whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing). 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.

UNIT 4	MECHANICS OF LAMINATES	9

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates.

UNIT 5	FLAT PLATE LAMINATES	9

Laminate Constitutive Equations – Coupling Interactions Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates

Total: 45 Periods

COURSE OUTCOMES

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

CO1:	Use of different material to design polymer matrix composites
CO2:	Use of different material to design metal matrix composites
CO3:	Use of different material to design ceramic matrix composites
CO4:	Analyze the use of different material to design composites
CO5:	Analyze flat plate laminates using mathematical techniques to predict the macroscopic properties of different Laminates

REFERENCES

1. Mathews F. L. and Rawlings R. D., "Composite Materials: Engineering and Science", 1st Edition, Chapman and Hall, London, England, 1994.
2. Chawla K. K., "Composite materials", Second Edition, Springer– Verlag, 1998.
3. Clyne, T. W. and Withers, P. J., "Introduction to Metal Matrix Composites", Cambridge University Press, 1993.
4. Strong, A.B., "Fundamentals of Composite Manufacturing", SME, 1989.
5. Sharma, S.C., "Composite materials", Narosa Publications, 2000.

COURSE CODE	COURSE NAME	L	T	P	C
191ME732	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3

COURSE OBJECTIVES

- To introduce Governing Equations of viscous fluid flows
- To introduce numerical modeling and its role in the field of fluid flow and heat transfer
- To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

UNIT 1	GOVERNING EQUATIONS AND BOUNDARY CONDITIONS	9

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations.

UNIT 2	FINITE DIFFERENCE METHODS FOR DIFFUSION	9

Derivation of finite difference equations – Simple finite difference methods – General Methods for first and second order accuracy. Example problems on elliptic equations-Steady-state heat conduction. Use of Finite Difference methods.

UNIT 3	FINITE VOLUME METHODS FOR DIFFUSION	9

Finite volume formulation for steady state One, Two and Three dimensional diffusion problems – Parabolic equations – Explicit and Implicit schemes – Example problems on parabolic equations – Use of Finite Volume methods.

UNIT 4	FINITE VOLUME METHOD FOR CONVECTION DIFFUSION	9

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, Quick Schemes.

UNIT 5	APPLICATIONS OFCOMPUTATIONAL FLUID DYNAMICS	9

Developing Flow in a curved Pipe, Combined convection in a horizontal tube, melting around a vertical pope, Turbulent flow and heat transfer in internally finned tubes, Thermal hydraulic analysis of a steam generator.

Total: 45 Periods

COURSE OUTCOMES	
Upon the completion of this course the students will be able to,	
CO1	Derive the governing equations and boundary conditions for Fluid dynamics
CO2	Analyze Finite difference methods for diffusion
CO3	Analyze Finite volume method for Convective diffusion
CO4	Analyze Flow field problems
CO5	Apply the fundamental concepts on fluid flow and heat flow

REFERENCES

1. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 2017.
2. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd., Second Edition, 2007.
3. Anil W. Date, "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005.
4. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
2. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005.
3. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.

COURSE CODE	COURSE NAME	L	T	P	C
191ME733	DESIGN OF JIGS FIXTURES AND PRESS TOOLS	3	0	0	3

(*Use of P S G Design Data Book is permitted)*

COURSE OBJECTIVES

- To understand the functions and design principles of Jigs, fixtures and press tools
- To gain proficiency in the development of required views of the final design

UNIT 1	LOCATING AND CLAMPING PRINCIPLES	9

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

UNIT 2	JIGS AND FIXTURES	9

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

UNIT 3	PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES	9

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

UNIT 4	BENDING AND DRAWING DIES	9

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

UNIT 5	FORMING TECHNIQUES AND EVALUATION	9

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

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Summarize the different methods of Locating Jigs and Fixtures and Clamping principles
CO2	Design and develop jigs and fixtures for given componentDiscuss the press working terminologies and elements of cutting dies
CO3	Distinguish between bending and drawing dies
CO4	Discuss the different types of forming techniques
CO5	Summarize the different methods of Locating Jigs and Fixtures and Clamping principles

REFERENCES

1. Joshi, P.H. “Jigs and Fixtures”, Second Edition, TMH Publishing Co., Ltd., New Delhi, 2010.
2. ASTME Fundamentals of Tool Design Prentice Hall of India.
3. Donaldson, Lecain and Goold “Tool Design”, 5th Edition, Tata McGraw Hill, 2017.
4. Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
5. Venkataraman. K., “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.

COURSE CODE	COURSE NAME	L	T	P	C
191ME734	MECHATRONICS	3	0	0	3

COURSE OBJECTIVES

- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

UNIT 1	INTRODUCTION	9

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light

UNIT 2	MICROPROCESSOR AND MICROCONTROLLER	9

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram,.

UNIT 3	PROGRAMMABLE PERIPHERAL INTERFACE	9

Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT 4	PROGRAMMABLE LOGIC CONTROLLER	9

Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT 5	ACTUATORS AND MECHATRONIC SYSTEM DESIGN	9

Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Discuss the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems and sensor technology

CO2	Discuss the architecture of Microprocessor and Microcontroller, Pin Diagram, Addressing Modes of Microprocessor and Microcontroller
CO3	Discuss Programmable Peripheral Interface, Architecture of 8255 PPI, and various device interfacing
CO4	Explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.
CO5	Discuss various Actuators and Mechatronics system using the knowledge and skills acquired through the course and also from the given case studies

REFERENCES

1. Bolton, “Mechatronics”, Prentice Hall, 2008 2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Prentice Hall, 2008.
2. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
3. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2013.
4. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, PWS publishing company, 2007.
5. Krishna Kant, “Microprocessors & Microcontrollers”, Prentice Hall of India, 2007.
6. Michael B.Histand and Davis G.Alciatore, “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 2007.

COURSE CODE	COURSE NAME	L	T	P	C
191ME735	SUPPLY CHAIN MANAGEMENT	3	0	0	3

COURSE OBJECTIVES

- To provide an insight on the fundamentals of supply chain networks, tools and techniques.

UNIT 1	INTRODUCTION	9

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

UNIT 2	SUPPLY CHAIN NETWORK DESIGN	9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions.

UNIT 3	LOGISTICS IN SUPPLY CHAIN	9

Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation –Routing and scheduling in transportation.

UNIT 4	SOURCING AND COORDINATION IN SUPPLY CHAIN	9

Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

UNIT 5	SUPPLY CHAIN AND INFORMATION TECHNOLOGY	9

The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain.

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Describe the basics of Logistics and Supply chain Management

CO2	Apply the concepts of supply chain networks and functions
CO3	Explain the role of Logistics in supply chain networks and functions
CO4	Explain the different ways of sourcing and coordination in supply chain
CO5	Explain the role of Information Technology in Supply chain Management

REFERENCES

1. Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and Operation", Pearson Education, 2010.
2. Jeremy F.Shapiro, "Modeling the Supply Chain", Thomson Duxbury, 2002.
3. Srinivasan G.S, "Quantitative models in Operations and Supply Chain Management, PHI, 2010
4. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, "Logistics", PHI 2002.
5. James B.Ayers, "Handbook of Supply Chain Management", St.Lucle press, 2000.

COURSE CODE	COURSE NAME	L	T	P	C
191ME736	INDUSTRIAL SAFETY ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To impart the students knowledge on safety engineering fundamentals and safety management practices.

UNIT 1	INTRODUCTION	9

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

UNIT 2	CHEMICAL HAZARDS	9

Chemical exposure – Toxic materials – Ionizing Radiation and Non-ionizing Radiation - Industrial Hygiene – Chemical Fire Hazards, Industrial Toxicology.

UNIT 3	ENVIRONMENTAL CONTROL	9

Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.

UNIT 4	HAZARD ANALYSIS	9

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment

UNIT 5	SAFETY REGULATIONS	9

Explosions – Disaster management – Pandemic related standards, OSHA standards, catastrophe control, hazard control, Safety education and training - Factories Act, Safety regulations Product safety – case studies.

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Explain modern safety concepts for engineering operations.
CO2	Identify and prevent chemical hazards through analysis.
CO3	Identify and prevent environmental hazards through analysis.
CO4	Identify and prevent mechanical hazard through analysis.

CO5	Apply proper safety techniques on safety engineering and management

REFERENCES

1. John V.Grimaldi, "Safety Management", AITBS Publishers, 2003.
2. Safety Manual, "EDEL Engineering Consultancy", 2000.
3. David L.Goetsch, "Occupational Safety and Health for Technologists", 5th Edition, Engineers and Managers, Pearson Education Ltd., 2005.

COURSE CODE	COURSE NAME	L	T	P	C
191ME737	NOISE VIBRATION AND HARSHNESS	3	0	0	3

COURSE OBJECTIVES

- To impart the student an understanding of the sources of noise vibration and harshness in automobiles and make design modifications to reduce the vibration and elimination of noise and harshness to improve the life of the components

UNIT 1	BASICS OF VIBRATION	9

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.

UNIT 2	BASICS OF NOISE	9

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

UNIT 3	AUTOMOTIVE NOISE SOURCES	9

Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine necessary contributed noise, transmission noise, aerodynamic noise, tire noise, brake noise.

UNIT 4	CONTROL TECHNIQUES	9

Vibration isolation, tuned absorbers, un-tuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.

UNIT 5	METHODS FOR NOISE CONTROL	9

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Summarize the basics of vibration
CO2	Summarize the basics of noise
CO3	Explain the Sources of Automotive noise
CO4	Discuss the Control techniques for vibration
CO5	Describe the sources and control of noise

REFERENCES

1. Singiresu S.Rao, "Mechanical Vibrations", 6th Edition, Pearson Education, 2016.
2. Balakumar Balachandran and Edward B. Magrab, "Fundamentals of Vibrations", 1 stEditon, Cengage Learning, 2009
3. Benson H. Tongue, "Principles of Vibrations", 2 nd Edition, Oxford University, 2007
4. Bernard Challen and RodicaBaranescu - "Diesel Engine Reference Book", Second Edition, SAE International, 1999.
5. David Bies and Colin Hansen, "Engineering Noise Control – Theory and Practice",4th Edition, E and FN Spon, Taylore & Francise e-Library, 2009
6. Grover. G.T., "Mechanical Vibrations", Nem Chand and Bros., 2009

COURSE CODE	COURSE NAME	L	T	P	C
191ME738	NON DESTRUCTIVE TESTING AND EVALUATION	3	0	0	3

COURSE OBJECTIVES

- To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.

UNIT 1	OVERVIEW OF NDT	9

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection – Unaided and aided.

UNIT 2	SURFACE NDE METHODS	9

Liquid Penetrant Testing - Principles, Interpretation and evaluation of demagnetization, Residual magnetism. types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, test indications

UNIT 3	THERMOGRAPHY AND EDDY CURRENT TESTING (ET)	9

Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT 4	ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)	9

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications

UNIT 5	RADIOGRAPHY (RT)	9

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, films graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xerox-Radiography, Computed Radiography, Computed Tomography

Total: 45 Periods

COURSE OUTCOMES

Upon the completion of this course the students will be able to,	
CO1	Explain the fundamental concepts of NDT
CO2	Discuss the different methods of NDE
CO3	Explain the concept of Thermography and Eddy current testing
CO4	Explain the concept of Ultrasonic Testing and Acoustic Emission
CO5	Explain the concept of Radiography

REFERENCES

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010
3. Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
4. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005.

COURSE CODE	COURSE NAME	L	T	P	C
191ME739	OPERATIONS RESEARCH	3	0	0	3

COURSE OBJECTIVES

- To provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems

UNIT 1	LINEAR MODELS	9

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

UNIT 2	TRANSPORTATION MODELS AND NETWORK MODELS	9

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

UNIT 3	INVENTORY MODELS	9

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT 4	QUEUEING MODELS	9

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

UNIT 5	DECISION MODELS	9

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life – Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem.

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Apply the linear models for use in engineering and business problems
CO2	Apply transportation models and network models for use in engineering and business problems

CO3	Apply the inventory models for use in engineering and business problems
CO4	Apply the queuing models for use in engineering and business problems
CO5	Apply the decision models for use in engineering and business problems

REFERENCES

1. Hillier and Libeberman, “Operations Research”, Holden Day, 2005
2. Taha H.A., “Operations Research”, Sixth Edition, Prentice Hall of India, 2003.
3. Bazara M.J., Jarvis and Sherali H., “Linear Programming and Network Flows”, John Wiley, 2009.
4. Budnick F.S., “Principles of Operations Research for Management”, Richard D Irwin, 1990.
5. Philip D.T. and Ravindran A., “Operations Research”, John Wiley, 1992.
6. Shennoy G.V. and Srivastava U.K., “Operation Research for Management”, Wiley Eastern, 1994.

COURSE CODE	COURSE NAME	L	T	P	C
191ME7310	PRODUCT DESIGN AND DEVELOPMENT	3	0	0	3

COURSE OBJECTIVES

- The student will be introduced to concepts of product design and development through proper material selection and processing methods.

UNIT 1	DESIGN PROCESS	9

The design process - Morphology of Design - Design drawings - Computer Aided Engineering - Designing of standards - Concurrent Engineering - Product life cycle - Technological Forecasting - Market Identification - Competition Bench marking - Systems Engineering - Life Cycle Engineering - Human Factors in Design - Industrial Design.

UNIT 2	DESIGN METHODS	9

Creativity and Problem Solving - Product Design Specifications - Conceptual design - Decision theory - Embodiment Design - Detail Design - Mathematical Modeling - Simulation - Geometric Modeling - Finite Element Modeling - Optimization - Search Methods - Geometric Programming - Structural and Shape Optimization.

UNIT 3	INDUSTRIAL DESIGN AND DESIGN FOR ENVIRONMENT	9

Industrial Design - Need for Industrial Design - Impact of Industrial Design - Importance ofIndustrial Design - Industrial Design Process - Design for Environment - Environmental impacts - Environmentally friendly materials - Design for Environment Process

UNIT 4	MATERIAL SELECTION PROCESSING AND DESIGN	9

Material selection Process - Economics - Cost Vs Performance - Weighted property Index - Value Analysis - Role of Processing and Design - Classification of Manufacturing Process - Design for Manufacture - Design for Assembly - Design for castings, Forging, Metal Forming, Machining and Welding - Residual stresses - Fatigue, Fracture and Failure.

UNIT 5	ENGINEERING STATISTICS AND RELIABILITY	9

Probability - Distributions - Test of Hypothesis - Design of Experiments - Reliability Theory - Design of Reliability - Reliability centered Maintenance. Quality Engineering – Total Quality Concept - Quality Assurance - Statistics Process Control - Taguchi Methods - Robust Design - Failure Model Effect Analysis.

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Apply the design process for product development.
CO2	Apply the design methods for product development.
CO3	Apply the basics of industrial engineering and design for environment.
CO4	Apply the engineering principles for material selection processing and design.
CO5	Apply concepts of engineering statistics and reliability for design and development

REFERENCES

1. Dieter George E., “Engineering Design – A Materials and Processing Approach", McGraw Hill, International Edition Mechanical Engg ., Series ,1991.
2. Karl t. Ulrich and Steven d Eppinger "Product Design and Development” ,McGraw Hill, Edition 2000.
3. Palh .G. and Beitz .W., “Engineering Design ", Springer - Verlag , NY. 1985.
4. Ray .M.S., " Elements of Engg. Design ", Prentice Hall Inc . 1985.
5. Suh .N.P. , " The Principle of Design ", Oxford University Press , NY. 1990.

COURSE CODE	COURSE NAME	L	T	P	C
191ME831	ENGINEERING ECONOMICS	3	0	0	3

(Use of Interest tables is permitted)

COURSE OBJECTIVES

- To enable students to understand the fundamental economic concepts applicable to engineering and to learn the techniques.
- To interpret the intricacies of economic concepts resulting in enhanced performance and productivity.

UNIT 1	INTRODUCTION TO INDUSTRIAL ECONOMICS	9

Nature and scope of Economics - Importance of study of Economics for Engineers. Demand and Supply- Elasticity, cost concepts– Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis - V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

UNIT 2	VALUE ENGINEERING	9

Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor - Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

UNIT 3	CASH FLOW	9

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

UNIT 4	REPLACEMENT AND RISK ANALYSIS	9

Items deteriorating with time and items that fail completely, not accounting for time value of money and with accounting for time value of money, replacement policy for new and old machine with infinite horizon, group replacement - Risk in economic analysis, measuring risk investment, risk profiles, decision trees, formulation of discounted decision tree, simulation.

UNIT 5	DEPRECIATION	9

Depreciation- Introduction, Straight line method of depreciation, declining balance method ofdepreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public

alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.	
Total: 45 Periods	
COURSE OUTCOMES Upon the completion of this course the students will be able to,	
CO1	Apply the basics of economics and cost analysis to engineering and take economically sound decisions
CO2	Explain the fundamentals of value engineering
CO3	Discuss various case flow Methods with comparison of alternatives.
CO4	Estimate various financial possibilities in replacement and risk Analysis
CO5	Summarize the different types of techniques in ddepreciation methods

REFERENCES

1. PanneerSelvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2001
2. James L Riggs, Engineering Economics, Tata McGraw Hill Book Co., New Delhi, 2004
3. Chan S.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2011.
4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012.

COURSE CODE	COURSE NAME	L	T	P	C
191ME832	INTERNET OF THINGS FOR MECHANICAL ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To present a problem oriented in depth knowledge of IoT and Smart Manufacturing.
- To address the underlying concepts and methods behind IoT and Smart Manufacturing.

UNIT 1	THE INTERNET OF THINGS	9

An overview; Design Principles for Connected Devices; Internet Principles.Thinking about Prototyping – Costs versus ease of prototyping, prototyping andProduction, Open source versus closed Source.

UNIT 2	PROTOTYPING EMBEDDED DEVICES	9

Electronics, Embedded Computing Basics, Arduino/Raspberry Pi/ BeagleBone Black/ etc., Electric Imp and other notable platforms, Prototyping online Components – API Writing,Real Time Reactions, Other Protocols.

UNIT 3	INTERNET OF THINGS PRIVACY, SECURITY AND GOVERNANCE	9

Introduction, Overview of Governance, Privacy and Security Issues, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards aSecure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities.

UNIT 4	INTRODUCTION TO SMART MANUFACTURING	9

Concept of smart manufacturing, working of smart manufacturing, difference from conventional/legacy manufacturing-Smart Manufacturing Processes- ThreeDimensions: Demand Driven and Integrated Supply Chains, Dynamically OptimizedManufacturing Enterprises, Real Time, Sustainable Resource Management.

UNIT 5	SMART DESIGN AND FABRICATION	9

Smart Design/Fabrication - Digital Tools, Product Representation andExchange Technologies and Standards,Additive Manufacturing Systems and Standards.Mass Customization, Smart Machine Tools, Robotics and Automation (perception, manipulation,mobility, autonomy), Smart Perception – Sensor networks and Devices.

Total: 45 Periods

COURSE OUTCOMES

Upon the completion of this course the students will be able to,	
CO1	Identify different areas of IOT and Smart Manufacturing
CO2	Develop simple prototypes incorporating internet of things
CO3	Apply the principles of privacy in internet of things aapplications
CO4	Identify the smart manufacturing applications for all the areas in day to day life
CO5	Identify process sequence for smart design and fabrication in all the areas in day to day life

REFERENCES

1. A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013.
2. N. Vengurlekar and P. Bagal, Database Cloud Storage: The Essential Guide toOracle Automatic Storage Management, 1st edition, McGraw-Hill Education, 2013.
3. M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010.

COURSE CODE	COURSE NAME	L	T	P	C
191ME833	MAINTENANCE ENGINEERING	3	0	0	3

COURSE OBJECTIVES

- To enable the student to understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.
- To explain the different maintenance categories like preventive maintenance, condition monitoring and repair of machine elements.
- To illustrate some of the simple instruments used for condition monitoring in industry

UNIT 1	PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING	9

Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity– Importance and benefits of sound Maintenance systems – Reliability and machine availability –MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.

UNIT 2	MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE	9

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – Total Productive Maintenance philosophy - Makigami Analysis.

UNIT 3	CONDITION MONITORING	9

Condition Monitoring – Cost comparison with and without condition monitoring – On-load testing and offload testing – Methods and instruments for condition monitoring – Temperature sensitive tapes – Pistol thermometers – wear-debris Analysis.

UNIT 4	REPAIR METHODS FOR BASIC MACHINE ELEMENTS	9

Repair methods for beds, slide ways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.

UNIT 5	REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT	9

Repair methods for Material handling equipment - Equipment records –Job order systems -Use of computers in maintenance. Machines for maintenance- Diagnostic modules in modern day maintenance

Total: 45 Periods

COURSE OUTCOMES

Upon the completion of this course the students will be able to,	
CO1	Implement the maintenance function and different practices in industries for the successful management of maintenance activities
CO2	Explain the Maintenance policies and preventive maintenance policies in industry applications.
CO3	Analysis various Condition monitoring techniques and its applications
CO4	Explain the various repairing methods in machine elements
CO5	Apply the various repairing methods in material handling equipment

REFERENCES

1. Srivastava S.K., "Industrial Maintenance Management", S. Chand and Co., 1981
2. Venkataraman .K, "Maintancence Engineering and Management", PHI Learning, Pvt. Ltd., 2007
3. Bhattacharya S.N., "Installation, Servicing and Maintenance", S. Chand and Co., 1995
4. White E.N., "Maintenance Planning", I Documentation, Gower Press, 1979.
5. Davies, "Handbook of Condition Monitoring", Chapman & Hall, 1996.

COURSE CODE	COURSE NAME	L	T	P	C
191ME834	PRODUCTION PLANNING AND CONTROL	3	0	0	3

COURSE OBJECTIVES

- To understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control
- To know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP)

UNIT 1	INTRODUCTION	9

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

UNIT 2	WORK STUDY	9

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data Predetermined motion time standards.

UNIT 3	PRODUCT PLANNING AND PROCESS PLANNING	9

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

UNIT 4	PRODUCTION SCHEDULING	9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing – Production Control systems Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT 5	INVENTORY CONTROL AND RECENT TRENDS IN PPC	9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic

lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of just in time systems-Fundamentals of MRP II and ERP.
Total: 45 Periods

COURSE OUTCOMES	
Upon the completion of this course the students will be able to,	
CO1	Select a suitable types of production for a given type of product
CO2	Prepare work study for the product development
CO3	Prepare production planning for a given type of product
CO4	Prepare production scheduling for a given type of product
CO5	Apply recent concepts in production planning and control and MRP II and ERP

REFERENCES

1. James. B. Dilworth,"Operations management – Design, Planning and Control for manufacturing and services" McGraw Hill International edition 1992.
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.
3. Chary. S.N., "Theory and Problems in Production & Operations Management", TMH, 1995.
4. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000.

COURSE CODE	COURSE NAME	L	T	P	C
191ME835	ROBOTICS AND AUTOMATION	3	0	0	3

COURSE OBJECTIVES

- To understand the functions of the basic components of a robot
- To study the use of various types of end of effectors and sensors

UNIT 1	FUNDAMENTALS OF ROBOT	9

Robot - Definition - Robot Anatomy - Co ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications. Introduction to Collaborative robot (cobot).

UNIT 2	ROBOT DRIVE SYSTEMS	9

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives.

UNIT 3	ROBOT END EFFECTORS	9

End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT 4	SENSORS FOR ROBOTS	9

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors.

UNIT 5	MACHINE VISION FOR ROBOTS	9

Camera, Frame Grabber, Sensing and Digitizing Image Data, Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications Inspection, Identification, Visual Serving and Navigation.

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Select a suitable types of production for a given type of product
CO2	Prepare work study for the product development
CO3	Prepare production planning for a given type of product
CO4	Prepare production scheduling for a given type of product
CO5	Apply recent concepts in production planning and control and MRP II and ERP

REFERENCES

1. Klafter R.D., Chmielewski T.A and Negin M., "Robotic Engineering - An Integrated Approach", Prentice Hall, 2003.
2. Groover M.P., "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2001

COURSE CODE	COURSE NAME	L	T	P	C
191ME541	ADVANCED MATERIALS	3	0	0	3

COURSE OBJECTIVES

- To provide overview of material properties and applications in the electrical and electronics engineering

UNIT 1	IONIC CONDUCTION	9

Review of defect equilibrium and diffusion mechanism, theory of ionic conduction, conduction in glasses, application in sensors and batteries, conducting polymers and organic semiconductors, piezoelectric materials

UNIT 2	DIELECTRIC AND MAGNETIC MATERIALS	9

Dielectric constant and polarization, polarization mechanism, linear and nonlinear dielectric, pyro-piezo, and ferroelectric properties, application magnetization diamagnetism paramagnetism, polypararnagnetism, ferro, antiferro, and ferri magnetism. Soft and hard magnet materials, permanent magnet and transformers

UNIT 3	ELECTRONIC MATERIALS	9

Electron dynamics and concept of holes, conductivity in relation to band structure, direct and indirect and gap, Degenerate and non-degenerate semiconductor, intrinsic and extrinsic semiconductor, application of semiconductor, DC and AC conductivity of metals, Hall effect and Magnetoresistance, Thermal conductivity and specific heat of material, thermo power of metals.

UNIT 4	ELECTRONIC MATERIALS FOR INDUSTRY	9

Carrier statistics in semiconductor, semiconductor materials purification, and crystals growth, epitaxy, CVD and, MBE, Physical vapor deposition (sputtering, evaporation, etc), P-N junction, Schottky & MaS device structures, doping by implant and diffusion, ion implantation, patterning, etchlithography, empirical rule, alloy design, very large sea integration (VLSI).

UNIT 5	OPTICAL MATERIALS	9

optical materials, electron-hole recombination, solid state LED's, Laser and IR-detector, band gap engineering, light interaction with materials—transparency, translucency, opacity, refraction and refractive index, reflection, absorption and transmission.

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Apply the basic principles of ionic conduction
CO2	Relate and differentiate dielectric and magnetic materials
CO3	Identify suitable electronic materials for a practical applications
CO4	Identify suitable electronic materials for a industrial applications
CO5	Apply the principles of optical materials for practical applications

REFERENCES

1. Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, Revised Indian Edition 2014
2. DR Askeland, " The Science and Engineering of Materials" PWS Publishing, ".1994
3. G.E. D Dieter, George Ellwood, and David J. Bacon," Mechanical Metallurgy" Vol. 3. , New York: McGraw-hill, 1976.
4. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., 2015
5. Ashby, Michael F., and David RH Jones. "Engineering Materials." (2012).edition, Dorling Kindersley, 2012.

COURSE CODE	COURSE NAME	L	T	P	C
191ME542	DESIGN THINKING	3	0	0	3

COURSE OBJECTIVES

- To provide step by step in-depth understanding on various aspects of innovation, creativity and evolving business modelsto students.

UNIT 1	INTRODUCTION TO DESIGN THINKING	9

Introduction - Create Thinking - Generating Design Ideas - Lateral Thinking – Analogies – Brainstorming - Mind mapping - National Group Technique – Synectics - Development of work - Analytical Thinking.

UNIT 2	EMPATHIZE PHASE	9

Identifying a design challenge- ways to conduct design research by observing and engaging- Deliverables for the Empathy Stage-A framework for empathy in design.

UNIT 3	ANALYZE PHASE	9

Use of empathy map, Organization of design concept and design methods, Engineering Design - Descriptive and prescriptive model, Design decisions and development of design.

UNIT 4	IDEATION PHASE	9

Steps in Ideate Phase, creative process and creative principles, Creativity techniques, Evaluation of ideas, How to prototype, Prototype Phase, Lean Startup Method for Prototype Development, Visualization and presentation techniques.

UNIT 5	TEST PHASE	9

Steps in test Phase, Tips for interviews, Tips for surveys, Kano Model, Desirability Testing, ways to conduct a workshop, Requirements for the space, Material requirements, Agility for Design Thinking.

Total: 45 Periods

COURSE OUTCOMES

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

CO1	Apply the basic techniques for design thinking
CO2	Apply the techniques for empathizing a design thinking

CO3	Apply the techniques of design thinking for analysis
CO4	Apply the techniques of design thinking for ideation
CO5	Apply the techniques of design thinking for testing

REFERENCES

1. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage learning (International edition) Second Edition, 2013.
2. Yousef Haik and Tamer M.Shahin, "Engineering Design Process", Cengage Learning, Second Edition, 2011.
3. Otto. K and Wood, K, Product Design, Pearson Education, 2001.
4. Pahl. G and Beitz. G, Engineering Design, Springer, 1996.

COURSE CODE	COURSE NAME	L	T	P	C
191ME543	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3

COURSE OBJECTIVES

- To expose students to analysis the energy data of industries, carryout energy accounting and balancing, conduct energy audit and suggest methodologies for energy savings and utilize the available resources in optimal ways.

UNIT 1	INTRODUCTION	9

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT 2	ELECTRICAL SYSTEMS	9

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT 3	THERMAL SYSTEMS	9

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators& Refractories.

UNIT 4	ENERGY CONSERVATION IN MAJOR UTILITIES	9

Energy conservation inPumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets.

UNIT 5	ECONOMICS	9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept .

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Relate the analyze the energy data of industries and carry out energy accounting and balancing

CO2	Calculate the energy savings in electrical systems.
CO3	Calculate the energy savings in thermal systems
CO4	Carry out energy conservation procedures in major utilities
CO5	Suggest methodologies for energy savings

REFERENCES

1. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Pub., Washington, 1988.
3. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
4. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
5. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
6. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987.

COURSE CODE	COURSE NAME	L	T	P	C
191ME544	LEAN SIX SIGMA	3	0	0	3

COURSE OBJECTIVES

- To gain insights about the importance of lean manufacturing and six sigma practices

UNIT 1	LEAN & SIX SIGMA BACKGROUND AND FUNDAMENTA	9

Historical Overview – Definition of quality – What is six sigma -TQM and Six sigma – lean manufacturing and six sigma- six sigma and process tolerance – Six sigma and cultural changes –six sigma capability – six sigma need assessments - implications of quality levels, Cost of Poor Quality (COPQ), Cost of Doing Nothing – assessment questions.

UNIT 2	THE SCOPE OF TOOLS AND TECHNIQUES	9

Tools for definition – IPO diagram, SIPOC diagram, Flow diagram, CTQ Tree, Project Charter –Tools for measurement, Flow process charts, Process Capability Measurement, Tools for analysis – interrelationship diagram, overall equipment effectiveness, innovative problem solving – Tools for improvement — Tools for control .

UNIT 3	SIX SIGMA METHODOLOGIES	9

Design For Six Sigma (DFSS),Design For Six Sigma Method - Failure Mode Effect Analysis(FMEA), FMEA process - Risk Priority Number (RPN)- Six Sigma and Leadership, committed leadership – Change Acceleration Process (CAP)- Developing communication plan – Stakeholder

UNIT 4	SIX SIGMA IMPLEMENTATION AND CHALLENGES	9

Tools for implementation – Supplier Input Process Output Customer (SIPOC) – Quality Function Deployment or House of Quality (QFD) – alternative approach –implementation – leadership training, close communication system, project selection – project management and team –champion training – customer quality index – challenges – program failure, CPQ Vs six sigma, structure the deployment of six sigma – cultural challenge – customer/internal metrics

UNIT 5	EVALUATION AND CONTINUOUS IMPROVEMENT METHODS	9

Evaluation strategy – the economics of six sigma quality, Return on six Sigma (ROSS), ROI, poor project estimates – continuous improvement – lean manufacturing – value, customer focus, Perfection, focus on waste, overproduction – waiting, inventory in process (IIP), processing waste, transportation, motion, making defective products, underutilizing people – Kaizen – 5S.

TOTAL: 45 PERIODS

COURSE OUTCOMES	
Upon the completion of this course the students will be able to,	
CO1	Relate the tools and techniques of lean sigma
CO2	Apply tools and techniques of lean sigma to increaseproductivity
CO3	Relate the techniques and methodologies of lean sigma
CO4	Explain about the six sigma implementation and challenges
CO5	Explain about evaluation and continuous improvement methods

REFERENCES

1. Michael L.George, David Rownalds, Bill Kastle, What is Lean Six Sigma, McGraw – Hill,2003
2. Thomas Pyzdek, The Six Sigma Handbook, McGraw-Hill,2000
3. Fred Soleimannejed , Six Sigma, Basic Steps and Implementation, AuthorHouse, 2004
4. Forrest W. Breyfogle, III, James M. Cupello, Becki Meadows, Managing Six Sigma: A Practical Guide to Applying, Assessing, and Implementing the Strategy That Yields Bottom-Line Success, John Wiley & Sons, 2000
5. James P. Womack, Daniel T.Jones, Lean Thinking, Free Press Business, 2003

COURSE CODE	COURSE NAME	L	T	P	C
191ME545	MATERIAL SCIENCE AND TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES

- To provide comprehensive overview of metallic materials, engineering materials, ceramic materials, polymers & composites, magnetic & electronic materials and synthesis and characterization techniques

UNIT 1	METALLIC MATERIALS, ENGINEERING MATERIALS	9

Classification of steel and cast Iron microstructure, properties and application. Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

UNIT 2	CERAMIC MATERIALS	9

Crystal chemistry — structure and bonding in materials, ceramic raw materials, production of powders by chemical and physical mean, powder consolidation, addition in ceramic processing, sintering and sintering theory, cold and hot isostatic pressing, processing of electronic ceramic, sol-gel processing.

UNIT 3	POLYMERS & COMPOSITES	9

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics - properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON –Composites-Classifications-Metal Matrix and FRP - Applications of Composites.

UNIT 4	MAGNETIC & ELECTRONIC MATERIALS	9

Electrical, magnetic and dielectric properties of materials. Electron dynamics and concept of holes, conductivity in relation to band structure, direct and indirect band gap, Degenerate and non-degene. lntrinsic and extrinsic semiconductor, application of semiconductor, DC and AC conductivity of metals, Hall effect and Magnetoresistance, Thermal conductivity and specific heat of material, thermo power of meals. Ionic conduction-review of defect equilibrium and diffusion mechanism

UNIT 5	CHARACTERIZATION TECHNIQUES	9

Thermal analysis tools, Thermometry and dilatometry, calorimetry, differential scanning calorimetry (DSC), DTA, Temperature modulates alorimetry, Thermomechanical analysis, DMA and DETA, Therrnogravimetry, X-ray fluorescence, photoluminescence, UV photoelectron spectroscopy, Fourier transform JR spectroscopy, Laser Raman spectroscopy

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
Upon the completion of this course the students will be able to,	
CO1	Select suitable metallic material based on application
CO2	Compare the properties of ceramic materials and choose a suitable process for the ceramics
CO3	Identify right plastic material as per the engineering purpose
CO4	Analyse the effect of magnetism and conductivity property in electronic materials
CO5	Identify the effect of the characterization technique on a given material

REFERENCES

1. Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill Book Company, 1997.
2. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., 2015.
3. Barsoum, W. M. "Fundamentals of Ceramics, IoP Publishing." 2003.
4. Suryanarayana, 'Testing of Metallic Materials', Prentice Hall India, 1979.
5. Rose R. M., Shepard, L. A., Wulff, J., 'Structure and Properties of Materials', Volume III, 4th Edition, John Wiley, 1984.

COURSE CODE	COURSE NAME	L	T	P	C
191ME546	RENEWABLE ENERGY SOURCES	3	0	0	3

COURSE OBJECTIVES

- To introduce the new methodologies technologies for effective utilization of renewable energy sources.

UNIT 1	INTRODUCTION	9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in TamilNadu, India and around the World – Potentials – Achievements Applications – Economics of renewable energy systems.

UNIT 2	SOLAR ENERGY	9

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

UNIT 3	WIND ENERGY	9

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects

UNIT 4	BIO ENERGY	9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Biomass Application, BiomassFeedstocks, Biomass to Biofuel Supply Chain

UNIT 5	OTHER RENEWABLE ENERGY SOURCES	9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage - Fuel Cell Systems – Hybrid Systems, Greenhouse Gas and its effect on climate change.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Identify the ways for effective utilization of renewable energy sources.
CO2	Relate and analyze the various solar energy based renewable energy generation.

CO3	Relate and analyze the various wind energy based renewable energy generation
CO4	Relate and analyze the various Bio-energy based renewable energy generation
CO5	Identify the merits of new methodologies and technologies for renewable energy generation

REFERENCES

1. Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.
2. Twidell, J.W. & Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 2006.
3. Sukhatme. S.P., "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
4. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
5. Tiwari. G.N., Solar Energy – "Fundamentals Design, Modelling & Applications", Narosa Publishing House, New Delhi, 2002.
6. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
7. Johnson Gary, L. "Wind Energy Systems", Prentice Hall, New York, 1985
8. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2010
9. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2009.

COURSE CODE	COURSE NAME	L	T	P	C
191ME547	TESTING OF MATERIALS	3	0	0	3

COURSE OBJECTIVES

- To provide a comprehensive exposure to various destructive and non destructive testing methods of materials and its industrial applications

UNIT 1	INTRODUCTION TO MATERIALS TESTING	9

Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing.

UNIT 2	MECHANICAL TESTING	9

Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test, (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, applications.

UNIT 3	NON DESTRUCTIVE TESTING	9

Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT 4	MATERIAL CHARACTERIZATION TESTING	9

Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.

UNIT 5	THERMAL BASED TESTING METHODS	9

Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo-mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Relate the analyze different ways for materials testing

CO2	Explain in detail about mechanical testing
CO3	Explain in detail about Non-destructive testing
CO4	Explain in detail about material characterization and testing
CO5	Suggest methodologies for testing the material using Thermo-mechanical and methods

REFERENCES

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Cullity, B. D., "Elements of X-ray diffraction", 3rd Edition, Addison-Wesley Company Inc., New York, 2000.
3. P. Field Foster, "The Mechanical Testing of Metals and Alloys" 7th Edition, Cousens Press, 2007.
4. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.
5. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA.
6. Brandon D.G., "Modern Techniques in Metallography", Von Nostrand Inc. NJ, USA, 1986.