	K.S.R. COLLEGE OF ENGINEERING (Autonomous) (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A" Grade) K.S.R. Kalvi Nagar, Tiruchengode – 637 215	CURRICULUM UG R - 2016

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Programme	B.E.- Mechanical Engineering

SEMESTER – I

Sl.No.	Course Code	Course Name	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	ES	Total
THEORY										
1.	16EN151	Technical English – I (Common to All Branches)	HS	3	0	0	3	30	70	100
2.	16MA152	Engineering Mathematics – I (Common to All Branches)	BS	3	1	0	4	30	70	100
3.	16PH153	Engineering Physics (Common to All Branches)	BS	3	0	0	3	30	70	100
4.	16CY154	Engineering Chemistry (Common to All Branches)	BS	3	0	0	3	30	70	100
5.	16ME145	Engineering Drawing (Common to AU & ME)	ES	1	3	0	4	30	70	100
6.	16CS146	Fundamentals of Computer and C Programming (Common to AU, CE, EC, EE & ME)	ES	3	0	0	3	30	70	100
PRACTICAL										
7.	-	Physics and Chemistry Laboratory* (Common to All Branches)	BS	-	-	3	-	-	-	-
8.	16CS127	Computer Practices Laboratory (Common to AU, CE, EC, EE & ME)	BS	0	0	3	2	50	50	100
9.	16AU127	Computer Aided Drawing Laboratory (Common to AU & ME)	ES	0	0	3	2	50	50	100
			Total	**16**	**4**	**9**	**24**		**800**	

* End semester examination only in II Semester

SEMESTER – II

Sl.No.	Course Code	Course Name	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	ES	Total
THEORY										
1.	16EN251	Technical English – II (Common to All Branches)	HS	3	0	0	3	30	70	100
2.	16MA242	Engineering Mathematics – II (Common to AU, CE, EC, EE, IT & ME)	BS	3	1	0	4	30	70	100
3.	16PH241	Applied Physics (Common to CE & ME)	BS	3	0	0	3	30	70	100
4.	16CY254	Environmental Science and Engineering (Common to All Branches)	HS	3	0	0	3	30	70	100
5.	16ME215	Basic Mechanics	ES	3	1	0	4	30	70	100
6.	16EE246	Basics of Electrical and Electronics Engineering (Common to AU, CE & ME)	ES	3	0	0	3	30	70	100
PRACTICAL										
7.	16GE027	Engineering Practices Laboratory (Common to AU,CE, EE & ME)	ES	0	0	3	2	50	50	100
8.	16GE228	Physics and Chemistry Laboratory (Common to All Branches)	BS	0	0	3	2	50	50	100
9.	16HR251	Career Development Skills - I (Common to All Branches)	EEC	-	2	-	-	50	50	100
			Total	**18**	**4**	**6**	**24**		**900**	

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SEMESTER – III

Sl.No.	Course Code	Course Name	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	ES	Total
THEORY										
1.	16MA341	Engineering Mathematics – III (Common to AU, CE, EC & ME)	BS	3	1	0	4	30	70	100
2.	16ME312	Engineering Thermodynamics	ES	3	1	0	4	30	70	100
3.	16ME313	Fluid Mechanics and Machinery	PC	3	0	0	3	30	70	100
4.	16ME314	Manufacturing Technology - I	PC	3	0	0	3	30	70	100
5.	16ME315	Machine Drawing	PC	1	0	2	3	30	70	100
6.	16EE336	Electrical Drives and Control	EEC	3	0	0	3	30	70	100
PRACTICAL										
7.	16ME321	Fluid Mechanics and Machinery Laboratory	PC	0	0	3	2	50	50	100
8.	16ME322	Manufacturing Technology Laboratory - I	PC	0	0	3	2	50	50	100
9.	16EE326	Electrical Drives and Control Laboratory	EEC	0	0	3	2	50	50	100
10.	16HR352	Career Development Skills - II (Common to All Branches)	EEC	-	2	-	-	50	50	100
			Total	16	4	11	26		1000	

SEMESTER – IV

Sl.No.	Course Code	Course Name	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	ES	Total
THEORY										
1.	16MA441	Numerical Methods (Common to AU, CE & ME)	BS	3	1	0	4	30	70	100
2.	16ME412	Kinematics of Machinery	PC	3	1	0	4	30	70	100
3.	16ME413	Strength of Materials	PC	3	1	0	4	30	70	100
4.	16ME414	Thermal Engineering	PC	3	0	0	3	30	70	100
5.	16ME415	Manufacturing Technology - II	PC	3	0	0	3	30	70	100
6.	16ME416	Engineering Materials and Metallurgy	PC	3	0	0	3	30	70	100
PRACTICAL										
7.	16ME421	Thermal Engineering Laboratory	PC	0	0	3	2	50	50	100
8.	16ME422	Strength of Materials Laboratory	PC	0	0	3	2	50	50	100
9.	16ME423	Manufacturing Technology Laboratory - II	PC	0	0	3	2	50	50	100
10.	16HR473	Career Development Skills - III	EEC	-	2	-	-	50	50	100
			Total	18	5	9	27		1000	

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SEMESTER – V

Sl.No.	Course Code	Course Name	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	ES	Total
THEORY										
1.	16MA531	Operations Research	ES	3	1	0	4	30	70	100
2.	16ME512	Dynamics of Machinery	PC	3	1	0	4	30	70	100
3.	16ME513	Design of Machine Elements	PC	3	0	0	3	30	70	100
4.	16ME514	Heat and Mass Transfer	PC	3	0	0	3	30	70	100
5.	16IT535	Programming with C++ and Java	EEC	3	0	0	3	30	70	100
6.	16EC536	Electronics and Microprocessor	EEC	3	0	0	3	30	70	100
PRACTICAL										
7.	16ME521	Dynamics of Machinery Laboratory	PC	0	0	3	2	50	50	100
8.	16ME522	Heat and Mass Transfer Laboratory	PC	0	0	3	2	50	50	100
9.	16EC526	Electronics and Microprocessor Laboratory	EEC	0	0	3	2	50	50	100
10.	16HR574	Career Development Skills – IV	EEC	-	2	-	-	50	50	100
			Total	18	4	9	26		1000	

SEMESTER – VI

Sl.No.	Course Code	Course Name	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	ES	Total
THEORY										
1.	16ME611	Design of Transmission Systems	PC	3	0	0	3	30	70	100
2.	16ME612	Computer Aided Manufacturing	PC	3	0	0	3	30	70	100
3.	16ME613	Refrigeration and Air Conditioning	PC	3	0	0	3	30	70	100
4.	16ME614	Quality, Reliability and Maintenance Engineering	PC	3	0	0	3	30	70	100
5.		Professional Elective - I	PE	3	0	0	3	30	70	100
6.		Open Elective - I	OE	3	0	0	3	30	70	100
PRACTICAL										
7.	16ME621	Computer Aided Design and Manufacturing Laboratory	PC	0	0	3	2	50	50	100
8.	16ME622	Comprehension and Technical Presentation	PC	0	2	0	1	50	50	100
9.	16ME623	Industry Internship and Project Phase - I	EEC	0	0	3	2	50	50	100
10.	16HR675	Career Development Skills – V	EEC	-	2	-	-	50	50	100
			Total	18	4	6	23		1000	

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SEMESTER – VII

Sl.No.	Course Code	Course Name	Category	L	T	P	C	CA	ES	Total
THEORY										
1.	16HS751	Professional Ethics (Common to All Branches)	HS	3	0	0	3	30	70	100
2.	16ME712	Finite Element Analysis	PC	3	0	0	3	30	70	100
3.	16ME713	Mechatronics	PC	3	0	0	3	30	70	100
4.	16ME714	Engineering Metrology and Measurements	PC	3	0	0	3	30	70	100
5.		Professional Elective – II	PE	3	0	0	3	30	70	100
6.		Open Elective – II	OE	3	0	0	3	30	70	100
PRACTICAL										
7.	16ME721	Mechatronics Laboratory	PC	0	0	3	2	50	50	100
8.	16ME722	Computer Aided Simulation and Analysis Laboratory	PC	0	0	3	2	50	50	100
9.	16ME723	Maintenance Laboratory	PC	0	0	3	2	50	50	100
10.	16ME724	Engineering Metrology and Measurements Laboratory	PC	0	0	3	2	50	50	100
			Total	**18**	**0**	**12**	**26**		**1000**	

SEMESTER – VIII

Sl.No.	Course Code	Course Name	Category	L	T	P	C	CA	ES	Total
THEORY										
1.	16HS002	Total Quality Management (Common to AU, CE, CS, EE, IT & ME)	HS	3	0	0	3	30	70	100
2.		Professional Elective – III	PE	3	0	0	3	30	70	100
3.		Professional Elective – IV	PE	3	0	0	3	30	70	100
PRACTICAL										
4.	16ME821	Project Phase - II	EEC	0	0	12	6	50	50	100
			Total	**9**	**0**	**12**	**15**		**400**	

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List of Electives		

SI.No.	Course Code	Course Name	Specialization	Hours/ Week			Credit	Maximum Marks		
				L	T	P	C	CA	ES	Total
1.	16MA686	Probability and Statistics	S1	3	0	0	3	30	70	100
2.	16ME662	Design of Jigs, Fixtures and Press tools	S2	3	0	0	3	30	70	100
3.	16ME663	Introduction to Aircraft Industry and Aircraft Systems	S2	3	0	0	3	30	70	100
4.	16ME664	Power Plant Engineering	S3	3	0	0	3	30	70	100
5.	16ME665	Nuclear Engineering	S3	3	0	0	3	30	70	100
6.	16ME666	Gas Dynamics and Jet Propulsion	S3	3	0	0	3	30	70	100
7.	16ME667	Composite Materials	S4	3	0	0	3	30	70	100

Table title: **PROFESSIONAL ELECTIVE - I (SEMESTER – VI)**

SI.No.	Course Code	Course Name	Specialization	Hours/ Week			Credit	Maximum Marks		
				L	T	P	C	CA	ES	Total
1.	16ME761	Hydraulics and Pneumatics	S2	3	0	0	3	30	70	100
2.	16ME762	Value and Re-Engineering	S2	3	0	0	3	30	70	100
3.	16ME763	Design of Aircraft Structures	S2	3	0	0	3	30	70	100
4.	16ME764	Automobile Engineering	S3	3	0	0	3	30	70	100
5.	16ME765	Renewable Sources of Energy	S3	3	0	0	3	30	70	100
6.	16ME766	Fundamentals of Nano Science	S4	3	0	0	3	30	70	100
7.	16ME767	Entrepreneurship Development	S5	3	0	0	3	30	70	100

Table title: **PROFESSIONAL ELECTIVE - II (SEMESTER – VII)**

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List of Electives		

PROFESSIONAL ELECTIVE - III (SEMESTER – VIII)										
Sl.No.	Course Code	Course Name	Specialization	L	T	P	C	CA	ES	Total
1.	16ME861	Industrial Tribology	S2	3	0	0	3	30	70	100
2.	16ME862	Product Design and Development	S2	3	0	0	3	30	70	100
3.	16ME863	Vibration and Noise Control	S2	3	0	0	3	30	70	100
4.	16ME864	Thermal Turbo Machines	S3	3	0	0	3	30	70	100
5.	16ME865	Welding Technology	S4	3	0	0	3	30	70	100
6.	16ME866	Process Planning and Cost Estimation	S4	3	0	0	3	30	70	100

PROFESSIONAL ELECTIVE - IV (SEMESTER – VIII)										
Sl.No.	Course Code	Course Name	Specialization	L	T	P	C	CA	ES	Total
1.	16ME867	Optimization in Design	S2	3	0	0	3	30	70	100
2.	16ME868	Industrial Robotics	S2	3	0	0	3	30	70	100
3.	16ME869	Pressure Vessel and Piping Design	S2	3	0	0	3	30	70	100
4.	16ME871	Internal Combustion Engines	S3	3	0	0	3	30	70	100
5.	16ME872	Unconventional Machining Processes	S4	3	0	0	3	30	70	100
6.	16ME873	Flexible Manufacturing Systems	S4	3	0	0	3	30	70	100

S1-Mathematics   S2-Design Engineering

S3-Thermal Engineering   S4-Manufacturing Engineering

S5-Management Studies

LIST OF PROPOSED ONE CREDIT COURSES

Sl. No	Course Name	Number of Hours	Offered by Internal/ External*
1.	Drafting software (any one)	15	External
2.	Modeling software (any one)	15	External
3.	Analysis software (any one)	15	External
4.	Simulation software (any one)	15	External
5.	Energy Audit in Industry	15	External
6.	TOEFL / IELTS	15	External
7.	GRE / GATE	15	External
8.	Optimization Techniques (any one)	15	Internal
9.	Condition Monitoring	15	Internal
10.	Design for Manufacture and Assembly	15	Internal
11.	Design of Experiments	15	Internal
12.	Piping Design	15	Internal

COURSE COMPONENT SUMMARY

SL. No.	SUBJECT AREA	I	II	III	IV	V	VI	VII	VIII	CREDITS TOTAL	PERCENTAGE CREDITS
1	HS	3	6	-	-	-	-	3	3	15	7.85
2	BS	10	9	4	4	-	-	-	-	27	14.14
3	ES	11	9	4	-	4	-	-	-	28	14.65
4	PC	-	-	13	23	14	15	17	-	82	42.93
5	PE	-	-	-	-	-	3	3	6	12	6.28
6	OE	-	-	-	-	-	3	3	-	06	3.14
7	EEC	-	-	5	-	8	2	-	6	21	10.99
	TOTAL	24	24	26	27	26	23	26	15	191	100

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<u>**SEMESTER - I**</u>

16EN151	**TECHNICAL ENGLISH – I**	L	T	P	C
	(Common to All Branches)	3	0	0	3

Prerequisite: No Prerequisites are needed for enrolling into the course.

Objectives:

- *To develop basic conversation skills.*
- *To build vocabulary skills with the right choice of words.*
- *To improve students' understanding of grammar in context progressively.*

UNIT - I   GRAMMAR AND VOCABULARY   [09]

Synonyms & Antonyms – Tenses (Simple Present, Present Continuous, Present Perfect, Simple Past, and Simple Future) - Use of Modal Auxiliaries – Infinitive and Gerund – Preposition of Time, Place and Movement – Concord (Subject & Verb Agreement) - British & American Terminology – Phrasal Verbs (Put, Give, Look, Take, Get, Call) – Pick the Grammatically correct sentences – Impersonal passive – Technical Abbreviations and Acronyms

UNIT - II   LISTENING   [09]

Active Listening - Listening for the main idea - Predicting - Drawing inferences - Listening for specific details - Listening to News – Listening to Dialogues – Listening to Telephonic Conversation.

UNIT - III   PHONETICS AND SPOKEN ENGLISH   [09]

Consonant Sounds – Pronunciation guidelines related to Vowels and Consonant – Drills using Minimal pairs – Welcome Speech – Vote of Thanks – MoC – Anchoring – Role play in academic context.

UNIT - IV   READING   [09]

Intensive Reading – Predicting Content – Interpretation – Skimming and Scanning - Vocabulary Building - Inference – Context Based Meaning – Note making

UNIT - V   WRITING SKILLS   [09]

Need based Correspondence (request for joining hostel, bonafide certificate, In plant training & Industrial Visit) – Writing Instructions - Letter of Invitation (inviting , accepting and declining) – Paragraph writing with given hints - Letter to the Editor of a News paper.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

> *C01: Understand and apply Grammar in context for professional communication.*
> *C02: Understand the gist and specific information.*
> *C03: speak, express and interact in the society and place of study.*
> *C04: Critically interpret by reading a text and comprehend a given text.*
> *C05: Correspond and communicate for jobs.*

Text Book :

1. Dr.P.Rathna, English Work Book – I, VRB Publishers Pvt. Ltd., Chennai,2015.

Reference Books :

1. Meenakshi Raman. Technical Communication, Oxford University Press, New Delhi, 2004.
2. Seely, The Oxford Guide to Writing and Speaking, Oxford University Press, New Delhi, 2004.
3. M Ashra Rizvi, Effective Technical Communication, Tata McGRAW HILL, New Delhi, 2005.
4. P.Kiranmani Dutt, A course in Communication Skills,Cambridge University Press, New Delhi, 2008.

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SEMESTER - I

16MA152	**ENGINEERING MATHEMATICS – I**	L	T	P	C
	(Common to All Branches)	3	1	0	4

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objectives:

* *To study the concepts of Matrices and its Applications.*
* *To study the concepts and its applications of Ordinary Differential Equations.*
* *To improve ability in solving geometrical applications of differential calculus problems.*
* *To acquire knowledge in the concepts of functions of several variables.*
* *To study the concepts of three dimensional analytic geometry.*

UNIT - I　　　　MATRICES　　　　　　　　　　　　　　　　　　　　　[12]

Introduction – types of Matrices- Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) – Cayley-Hamilton theorem (statement only) and its applications – Quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT - II　　　　ORDINARY DIFFERENTIAL EQUATIONS　　　　　　　　[12]

Linear differential equations of second and higher order with constant coefficients – Differential equations with variable coefficients – Cauchy's and Legendre's linear equations – Method of variation of parameter - simultaneous first order linear differential equations with constant coefficients.

UNIT - III　　　　DIFFERENTIAL CALCULUS　　　　　　　　　　　　　[12]

Curvature in Cartesian co-ordinates – radius of curvature – Centre of curvature and Circle of curvature – Involutes and Evolutes – Envelopes (except evolutes as the envelope of normals) – Properties of envelopes and evolutes.

UNIT - IV　　　　FUNCTIONS OF SEVERAL VARIABLES　　　　　　　　[12]

Partial derivatives – Euler's theorem for homogenous functions – Jacobians – Taylor's series expansion - Maxima and Minima for functions of two variables – Method of Lagrangian multipliers.

UNIT - V　　　　THREE DIMENSIONAL ANALYTICAL GEOMETRY　　　　[12]

Equation of straight line – Angle between two lines - Coplanar lines and Shortest distance between skew lines (symmetrical form only) – Equation of a sphere – Plane section of a sphere – Orthogonal spheres.

Total (L: 45 T:15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to

　　C01: *Interpret the basics of Matrix applications in the field of engineering.*
　　C02: *Acquire knowledge in solving ordinary differential equations.*
　　C03: *Understand and apply the concepts of differential calculus problems.*
　　C04: *Improve skills in Developing and solving the functions of several variables.*
　　C05: *Understand the concepts of three dimensional analytical geometry.*

Text Book :

1. Ravish R singh and Mukul Bhatt, "Engineering Mathematics – I", McGraw Hill Publications, 3rd edition, New Delhi (2013).

Reference Books :

1. Grewal B.S,"Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, (2013), 43rd edition.
2. Bali N. P and Manish Goyal, "Text book on Engineering Mathematics", Laxmi Publications (p) Ltd. (2015), 6th edition.
3. H.K. Dass, "Advance Engineering Mathematics", S. Chand & company, (2015)-11th edition.

SEMESTER - I

16PH153	ENGINEERING PHYSICS	L	T	P	C
	(Common to All Branches)	3	0	0	3

Prerequisite: No Prerequisites are needed for enrolling into the course.

Objectives:

- *To understand the fundamentals of physics that have a direct application in the field of Engineering.*
- *To compute and analyze various problems related to Engineering Physics.*
- *To understand the basic concepts behind the Acoustics, Ultrasonics, Lasers, Optical fibers, solar cells & Photo devices, Quantum mechanics.*

UNIT - I   ACOUSTICS AND ULTRASONICS   [09]

Acoustics–Introduction – Classification of sound – Characteristics of musical sound – Loudness – Weber – Fechner law – Decibel – Absorption coefficient – Reverberation – Reverberation time – Sabine's formula: growth and decay (derivation) – Factors affecting acoustics of buildings and their remedies.Ultrasonics–Production –piezoelectric method – Properties – Velocity measurement: acoustical grating –Engineering applications– SONAR.

UNIT - II   LASERS AND APPLICATIONS   [09]

Introduction – Principle of Spontaneous emission and stimulated emission – Population inversion, pumping – Einstein's A and B coefficients (derivation). Types of lasers – Nd-YAG, $CO_2$and Semiconductor lasers (homo-junction and hetero-junction) – Qualitative Industrial Applications: Lasers in welding, heat treatment and cutting – Medical applications – Holography (construction and reconstruction).

UNIT - III   FIBER OPTICS AND APPLICATIONS   [09]

Principle and propagation of light in optical fibers – Numerical aperture and Acceptance angle (derivation) –Types of optical fibers (material, refractive index and mode) – Double crucible technique of fiber drawing – Splicing– Losses in optical fiber: attenuation, dispersion and bending –Fiber optical communication system (Block diagram) – Fiber optic sensors: temperature and displacement sensors –Medical Application: Endoscope.

UNIT - IV   SOLAR CELLS AND PHOTO DEVICES   [09]

Solar cells – classification – working- V-I characteristics – experiment - Materials for solar cell– Applications– Photoconductive devices – PIN and Avalanche photodiode –construction, working and characteristics – Light Emitting Diode – construction, working and characteristics – Applications: Voltage indicator and seven segment display.

UNIT – V   QUANTUM PHYSICS   [09]

Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory – Compton effect – Theory and experimental verification – Matter waves – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box .

Total = 45 Periods

Course Outcomes*: On completion of this course, the student will be able to*

- C01: *Describe the impact of engineering solutions in the constructional and designing environment.*
- C02: *Categorize the types of laser and utilize it for specific application based on their desirable requisite.*
- C03: *Comprehend the fundamental ideas of optical fibers and to fabricate it for the potential applications.*
- C04: *Exploit the concepts of photo devices for fabricating solar cells.*
- C05: *Enumerate the preambles of quantum physics and to implement its concepts to tackle the cumbersome Engineering problems.*

Text Books :

1. Dr.G.Senthil Kumar, "Engineering Physics – I" VRB Publishers Pvt Ltd, (2009).
2. V. Rajendran, "Engineering Physics" Tata McGraw Hill (2011).

References :

1. Brij Lal &Subramaniam, "A Text Book of Sound", S. Chand & Co Ltd, New Delhi, (2005).
2. Dr. P. Mani, "Engineering Physics – I", Dhanam Publications, Chennai, (2012).
3. S. Selladurai, "Engineering Physics-I",PHI Learning Pvt, Ltd., New Delhi, (2010)
4. Dr.S.Muthukumaran, G.Balaji and S.Masilamani, "Engineering Physics- I", Sri Krishna HI—Tech Publishing company Pvt. Ltd.(2010).
5. www.fadooengineers.com.

16CY154	**ENGINEERING CHEMISTRY**	L	T	P	C
	(Common to All Branches)	3	0	0	3

Prerequisite: *No Prerequisites are needed for enrolling into the course.*
Objectives:

- *To make the students conversant with basic concepts and applications of engineering polymers.*
- *To understand the principles and functioning of batteries, fuel cell and solar cell.*
- *To impart knowledge about the manufacture and uses of advanced engineering materials.*
- *To gain sound knowledge on the water treatment methods and its industrial applications.*
- *To acquaint the students with the basic concepts of corrosion mechanism and its control.*

UNIT - I   ENGINEERING POLYMERS   [09]

Polymer – definition- Degree of polymerization – functionality. Polymerisation - addition, condensation and co-polymerization – free radical mechanism of addition polymerization; Plastics – classification –thermosetting and thermoplastics. Properties of polymers- glass transition temperature and tacticity. Preparation, properties and uses of engineering polymers [PVC, nylon-6,6 , PET and SBR] ; Fabrication of polymers – compression and Injection moulding; Composites – FRP only.

UNIT - II   ENERGY STORAGE DEVICES   [09]

Batteries – primary batteries- alkaline batteries, secondary batteries-lead–acid, nickel–cadmium and lithium batteries. Fuel cells –H_2-O_2 fuel cell, solar cells-principle, applications and advantages; Nano batteries and its applications. Nuclear energy – fission and fusion reactions; Nuclear reactor – components and power generation - breeder reactor.

UNIT - III   ADVANCED ENGINEERING MATERIALS   [09]

Abrasives- Moh's scale of hardness- types –natural [Diamond] – synthetic [SiC]; Refractories- characteristics-classifications [acidic, basic and neutral refractories] –properties- refractoriness- RUL- porosity- thermal spalling; Lubricants – definition – function – characteristics- properties- viscosity index, flash and fire points, cloud and pour points , oiliness. Solid lubricants- graphite and MoS_2. Nano materials-CNT-synthesis [CVD, laser evaporation, pyrolysis]-applications –medicine, electronics, biomaterials and environment.

UNIT - IV   WATER AND ITS PURIFICATION TECHNIQUES   [09]

Hardness –types, equivalence of $CaCO_3$ [problems] ,units - estimation of hardness by EDTA method ; Boiler feed water – requirements, disadvantages of using hard water in boilers – scale and sludge –priming and foaming –caustic embrittlement- boiler corrosion. Softening methods- internal conditioning- calgon, carbonate, phosphate - external conditioning – zeolite process and ion exchange process; Desalination – reverse osmosis. Characteristics of potable water –domestic water treatment – break point chlorination.

UNIT - V   CHEMISTRY OF CORROSION AND ITS CONTROL   [09]

Electrochemical cells– types–single electrode potential and its determination; Electrochemical series –applications – corrosion – chemical corrosion – Pilling-Bedworth rule, electrochemical corrosion – mechanism, galvanic corrosion and differential aeration corrosion [Pitting corrosion, water line corrosion]; Factors influencing corrosion; Corrosion control – cathodic protection methods – sacrificial anode and impressed current methods–corrosion inhibitors.

Total = 45 Periods

Course Outcomes: *On completion of this course, the students will be able to*
> *C01: Know the preparation and fabrication of various types of polymers and composite materials.*
> *C02: Understand the usage of nuclear power plants and batteries for the production of electricity.*
> *C03: Gain knowledge in the manufacture and uses of advanced engineering materials.*
> *C04: Familiarized with the water quality parameters and understand the various water treatment methods.*
> *C05: Perceive knowledge on the concept of corrosion and it's control.*

Text Books :

1 P.C. Jain and Monica Jain, Engineering Chemistry, Dhanpat Rai Pub. Co., 16th Edition, 2013.

2 Dr. A.Ravikrishnan, Engineering Chemistry, Srikrishna Hi-tech Publishing Company Pvt. Ltd. 14th Edition, 2014.

Reference Books :

1. B. Sivasankar, Engineering Chemistry, Tata McGraw-Hill Pub. Co. Ltd., 14th Edition, 2011.

2. S.S.Dara, A Text book of Engineering Chemistry, S.Chand & Co.Ltd., 10th Edition, 2005.

3. Dr. S. Vairam, Dr. P. Kalyani, Dr. Subaramesh, Engineering Chemistry, Wiley India Pvt.Ltd. 2nd Edition, 2013.

K.S.R. COLLEGE OF ENGINEERING (Autonomous)   **R 2016**

<u>**SEMESTER - I**</u>

16ME145	**ENGINEERING DRAWING**	L	T	P	C
	(Common to AU & ME)	1	3	0	4

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objective:

- *To develop students' graphic skill for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings.*

UNIT - I   PLANE CURVES AND ORTHOGRAPHIC PROJECTION   [12]

Introduction on drafting instruments, BIS conventions and specifications, Lettering and Dimensioning-Conics-Construction of ellipse, parabola and hyperbola by eccentricity method -Construction of cycloid-Construction of involutes-Drawing of tangents and normal to the above curves. Representation of three dimensional objects-General principles of orthographic projection- First angle projection.

UNIT - II   PROJECTION OF POINTS, LINES AND PLANE SURFACES   [12]

Projection of points and straight lines located in the first quadrant -Determination of true lengths and true inclinations - Projection of polygonal surface and circular lamina inclined to any one reference plane.

UNIT - III   PROJECTION OF SOLIDS   [12]

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

UNIT - IV   SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES   [12]

Sectioning of above solids in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other- Obtaining true shape of section. Development of lateral surfaces of simple and truncated solids-Prisms, pyramids, cylinders and cones.

UNIT - V   ISOMETRIC AND PERSPECTIVE PROJECTIONS   [12]

Principles of isometric projection - isometric scale -isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones. Perspective projection of prisms, pyramids and cylinders by visual ray method.

Total (L : 15 T : 45) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to

C01: Gain knowledge on basic drafting concepts, procedure for constructing plane curves and general principles of orthographic projections.

C02: Explicit the projection of points, lines and plane surfaces.

C03: Demonstrate the concepts of projection of solids.

C04: Perceive knowledge on sectioning the solids and developing the surfaces of solids.

C05: Construct isometric and perspective projection of solids.

Text Books :

1. Natarajan, K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai,2015.

2. Kumar, M.S., "Engineering Graphics", D.D. Publications, (2007).

Reference Books :

1. Venugopal & Prabhu Raja, V., "Engineering Graphics", New Age International (P) Limited   (2008).

2. Bhatt, N.D., "Engineering Drawing", Charotar Publishing House, 46th Edition, (2003).

3. Shah, B., and Rana, B.C., "Engineering Drawing", Pearson Education (2005).

4. Gopalakrishna, K.R., "Engineering Drawing" (Vol.I & II), Subhas Publications (1998).

5. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited.2008.

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SEMESTER – I

16CS146	FUNDAMENTALS OF COMPUTER AND C PROGRAMMING	L	T	P	C
	(Common to AU, CE, EC, EE & ME)	3	0	0	3

Prerequisite: No prerequisites are needed for enrolling into the course.

Objectives:

- *To Learn the organization of a digital computer.*
- *To think logically and write pseudo code or draw flowchart of a problem.*
- *To write simple programs using C language.*

UNIT - I   BASICS OF COMPUTERS   [09]

Generation and Classification of Computers – Basic Computer Organization – Number System and its Conversions – Problem Solving: Algorithm – Pseudo code – Flow Chart.

UNIT - II   C PROGRAMMING BASICS   [09]

Fundamentals – Structure of a 'C' program – Compilation and Linking processes – Constants, Variables – Data Types – Operators – Expressions – Managing Input and Output operations – Decision Making and Branching – Looping statements – Solving simple scientific and statistical problems.

UNIT - III   ARRAYS AND STRINGS   [09]

Arrays: Initialization – Declaration – One dimensional and Two dimensional arrays – String: String Operations – String Arrays – Simple programs: Sorting – Searching – Matrix operations.

UNIT - IV   FUNCTIONS AND POINTERS   [09]

Function: Declaration – Definition – Categories – Pass by value – Pass by reference – Recursion – Pointers: Definition – Initialization – Pointers arithmetic – Pointers to Pointers – Pointers and arrays – Example Problems.

UNIT - V   STRUCTURE AND UNION   [09]

Structure: Declaration – Definition – Structures within structures – Union – Programs using structure and Union – Storage classes – Pre-processor directives – Files.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

C01: Identify Basics of Computer.
C02: Write C Programs for solving simple scientific and statistical problems.
C03: Implement C programs for arrays and strings.
C04: Write C Programs using Functions and Pointers.
C05: Implement Simple C applications using Structures and Unions.

Text Book :

1. Ashok N.Kamathane, Computer Programming, Pearson Education, 2014.

References :

1. Pradip Dey, Manas Ghosh, Fundamentals of Computing and Programming in C, First Edition, Oxford University Press, 2013.
2. Anita Goel and Ajay Mittal, Computer Fundamentals and Programming in C, Dorling Kindersley India Pvt. Ltd., Pearson Education in South Asia, 2011.
3. Yashavant P. Kanetkar, Let Us C, BPB Publications, 2011.
4. Dromey R.G., How to Solve it by Computer, Pearson Education, Fourth Reprint, 2007.
5. Kernighan,B.W and Ritchie,D.M, The C Programming language, Second Edition, Pearson Education, 2006.
6. http://nptel.ac.in/courses/106105085/4.

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<u>**SEMESTER – I**</u>

PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
(Common to All Branches)	-	-	3	-

Prerequisites: *Knowledge in Engineering Physics , Chemistry and Materials science.*

Objectives:

- *To gain the practical knowledge and hands on experiences of understanding the physics concepts applied in optics, sound and thermal physics.*

- *To gain practical knowledge by applying theoretical principles and performing the following experiments.*

List of Experiments in Physics Laboratory

1. Determination of wavelength of laser using grating and the size of the particles.

2. Determination of thickness of the given material by Air – wedge method.

3. Determination of velocity of Ultrasonic waves and compressibility using Ultrasonic interferometer.

4. Spectrometer grating - Determination of wavelength of mercury spectrum.

5. Determination of thermal conductivity of a bad conductor by Lee's disc method.

List of Experiments in Chemistry Laboratory

1. Estimation of hardness in water by EDTA method.

2. Estimation of chloride in water sample by Argentometry.

3. Estimation of dissolved oxygen (DO) in water by winkler's method.

4. Estimation of copper in brass by EDTA method.

5. Determination of molecular weight and degree of polymerization using viscometry.

6. Determination of rate of corrosion of mild steel by weight loss method.

                                                                        Total = 30 Periods

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

 C01: *Comprehend the different physical parameters of optics and perceive the production of ultrasonic waves through inverse piezoelectric effect and to determine the velocity of sound waves in the given liquid.*

 C02: *Understand the principle of thermal conductivity thereby to calculate the thermal conductivity of various bad conductors like cardboard, mica, etc.*

 C03: *Know the applicability of water in various fields.*

 C04: *Know the composition of brass quantitatively and the molecular weight of the polymer.*

 C05: *Understand the nature of corrosion process.*

Text Books :
1. Physics Lab manual, Department of Physics, K.S.R. College of Engineering.
2. Chemistry Lab Manual, Department of Chemistry, K.S.R. College of Engineering.

Reference Books :
1. Dr.G.Senthilkumar, "Physics Lab manual", VRB Publications Pvt. Ltd.,(2006).
2. Advanced Practical Physical Chemistry by J.B. Yadav, GOEL Publishing House.
3. Advanced Practical Inorganic Chemistry by Gurdeep Raj, GOEL Publishing House.

Note:

- **A minimum of five experiments shall be offered in chemistry laboratory.**

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

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<u>**SEMESTER – I**</u>

		L	T	P	C
16CS127	**COMPUTER PRACTICES LABORATORY**	L	T	P	C
	(Common to AU, CE, EC, EE & ME)	0	0	3	2

Prerequisite: No prerequisites are needed for enrolling into the course.

Objective:

• *To gain the knowledge of PC hardware, Office software and simple applications using C programming.*

List of Experiments:

1. *Study Experiment*
   a) Study of parts of the PC.
   b) Study of Internet Connection.

2. *Word processing*
   a) Document creation, Text manipulation with Scientific notations.
   b) Table creation, Table formatting and Conversion.
   c) Mail merge and Letter preparation.
   d) Drawing - flow Chart.

3. *Spread Sheet*
   a) Chart - Line, XY, Bar and Pie.
   b) Formulas and functions.
   c) Inclusion of object and protecting the sheet.

4. *PowerPoint Presentation*
   Create simple power point presentation with animations.

5. *MS Access*
   Generate a student report using MS Access.

6. *Simple C Programming ***
   a) Conditional and looping Statements.
   b) Arrays and strings.
   c) Structures and Unions.
   d) Functions and pointers.

* For programming exercises Flow chart and pseudo code/algorithm are essential.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

C01: *Be familiar with creating a table, flow chart, mail merge and apply text manipulation in a word document.*

C02: *Design a spreadsheet for creating the charts and apply formulas and functions.*

C03: *Create power point presentation with animations and generate a report in MS access.*

C04: *Apply good programming design methods for program development.*

C05: *Design and implement C programs for simple applications.*

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<u>**SEMESTER - I**</u>

		L	T	P	C
16AU127	**COMPUTER AIDED DRAWING LABORATORY**	0	0	3	2
	(Common to AU & ME)				

Prerequisite: *No prerequisites are needed for enrolling into the course.*

Objective   :

• *To develop skill for using software to create 2D and 3D models.*

List of Experiments:

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute,relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg. V block, base of a mixie, simple stool, objects with hole and curves).
6. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.)
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
9. Drawing isometric projection of simple objects.
10. Creation of 3D models of simple objects and obtaining 2D multi-view drawings from 3D model.

Total = 45 Periods

LIST OF EQUIPMENT

SI. No.	Name of the Equipment	Qty.
1.	Pentium IV computer or better hardware, with suitable graphics facility	30 Nos.
2.	Licensed software for drafting and modeling	15 Nos.
3.	Laser Printer or Plotter to print / plot drawings	2 Nos.

Course Outcomes: On completion of this course, the students will be able to

    C01:   Use the software packages for drafting and modeling.
    C02:   Create 2D and 3D models of engineering components.
    C03:   Create, render, and manipulate 3D AutoCAD drawings and convert 2D drawings to 3D drawings.
    C04:   Demonstrate graphical skills appropriate to the level of the course work.
    C05:   Become familiar to draw special curves.

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<u>**SEMESTER - II**</u>

16EN251	**TECHNICAL ENGLISH – II**	L	T	P	C
	(Common to All Branches)	3	0	0	3

Prerequisite : *No Prerequisites are needed for enrolling into the course.*

Objective   :

- *To improve Listening, Speaking, Reading and Writing skills.*

UNIT - I   LANGUAGE FOCUS   [09]

Technical Vocabulary – Changing words from one form to another - Articles – Compound Nouns – Numerical Adjectives – Prefixes & Suffixes – Framing Questions – 'Wh' Question – Yes / No Question –Discourse markers - Cause and Effect Expression -Expression of Purpose – Editing text for Spelling and Punctuation.

UNIT - II   SPEAKING   [09]

Greetings and Introductions – Making Requests – Seeking Information – Inviting People – Likes & Dislikes- Instructions – Describing – Telephone Etiquette.

UNIT - III   READING   [09]

Critical reading, Making inference, Context based meaning - Transcoding (Interpretation of Charts).

UNIT - IV   PROFESSIONAL WRITING   [09]

Job Application and Resume - Report Writing - E-mail Writing - Business Correspondence – Calling for Quotations, Seeking Clarification, placing order and Complaint.

UNIT - V   LISTENING   [09]

Listening to fill up forms and gapped texts – Extensive Listening – Listening and Note taking - Listening for main ideas.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

   C01: *Comprehend and apply the enriched vocabulary, by knowing the basic grammatical structure in academic and professional contexts.*
   C02: *Recognize and use standard English in diverse situations.*
   C03: *Critically interpret by reading a text and comprehend a given text.*
   C04: *Write clearly in professional contest.*
   C05: *Enhance the listening skill for academic purposes.*

Text Book :
1. Dr.P.Rathna, English Work Book – II, VRB Publishers Pvt. Ltd., Chennai, 2016.

Reference Books :

1. Dr.S.Sumant,Technical English I, Tata McGraw Hill, Chennai (2012).

2. Dept. of Humanities and social sciences, Anna University, Chennai, English for Engineers and Technologists, Orient Longman, 2008.

3. HorySankarMukerjee, Business Communication, Oxford University Press, New Delhi (2013).

4. Department of English, English for Technologists and Engineers, Orient Black Swan, Chennai (2012).

K.S.R. COLLEGE OF ENGINEERING (Autonomous)

<u>SEMESTER - II</u>

16MA242	**ENGINEERING MATHEMATICS – II**	L	T	P	C
	(Common to AU, CE, EC, EE, IT & ME)	3	1	0	4

Prerequisite : *No Prerequisites are needed for enrolling into the course.*

Objectives :

- *To study the concepts of Laplace transforms.*
- *To acquire knowledge in finding inverse Laplace transforms techniques.*
- *To study the double and triple integrations and its applications.*
- *To know the basics of vector calculus along with classical theorems involving them.*
- *To understand the concepts of analytic functions, conformal mapping and bilinear transformations.*

UNIT - I   LAPLACE TRANSFORMATION   [12]

Laplace transforms – Conditions for existence – Transform of elementary functions – Basic properties – Transform of derivatives and integrals – Transform of unit step function and impulse functions – Initial and final value theorems Transform of periodic functions.

UNIT - II   INVERSE LAPLACE TRANSFORMATION   [12]

Inverse Laplace transforms – Convolution theorem (excluding proof) – Solution of linear ordinary differential equations of second order with constant coefficients.

UNIT - III   MULTIPLE INTEGRALS   [12]

Double integration – Cartesian coordinates – Change of order of integration – Triple integration in Cartesian co-ordinates – Area as double integral – Volume as triple integral.

UNIT - IV   VECTOR CALCULUS   [12]

Gradient Divergence and Curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and stokes' theorem – Simple problems involving cubes and rectangular parallelopipeds.

UNIT - V   ANALYTIC FUNCTIONS   [12]

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy – Riemann equation and Sufficient conditions (excluding proof) – Harmonic functions – Harmonic conjugate – Construction of analytic functions – Conformal mapping : w= z+c, cz, 1/z and bilinear transformations.

Total (L: 45 T:15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to

> C01: *Understand the fundamentals of Laplace transform and its applications.*
> C02: *Interpret the concepts of Inverse Laplace transforms and solving linear ODE .*
> C03: *Evaluate the area of the surface and volume using double and triple integrations.*
> C04: *Acquire the basics of vector calculus and its applications.*
> C05: *Understand and apply the concepts of analytic functions, conformal mapping and bilinear transformations.*

Text Book :

1. Ravish R Singh and Mukul Bhatt, "Engineering Mathematics II", McGraw Hill Publications, New Delhi, (2014), 1st Edition.

Reference Books :

1. Grewal B.S,"Higher Engineering Mathematics", TMH,New Delhi,9th edition, (2015).
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 7th Edition.(2015).
3. Bali N. P and Manish Goyal, "Text book of Engineering Mathematics", Laxmi Pub.(p) Ltd.,6th edition, (2011).

SEMESTER – II

16PH241	APPLIED PHYSICS	L	T	P	C
	(Common to CE & ME)	3	0	0	3

Prerequisite: *Knowledge in Engineering Physics.*

Objectives:
- *To explore the concepts of lattices and crystal structures.*
- *To describe the theory of conducting and superconducting materials.*
- *To explain the properties of magnetic and dielectric materials. Discuss about the various moduli of elasticity and their Relations and modern Engineering materials.*

UNIT - I   CRYSTAL PHYSICS   [09]

Crystalline and amorphous solids – lattice and unit cell – seven crystal system and Bravais lattices – Miller indices – d spacing in cubic lattice – atomic radius – coordination number – packing factor calculation for sc, bcc, fcc and hcp – crystal defects – point, line and surface defects.

UNIT - II   CONDUCTING AND SUPERCONDUCTING MATERIALS   [09]

Conductors – classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann - Franz law – Lorentz number – Draw backs of classical theory – Postulates of Quantum theory – Superconductivity – properties – type I and type II superconductors – BCS theory of superconductivity (Qualitative) – applications of superconductors – SQUID, cryotron and magnetic levitation.

UNIT - III   MAGNETIC AND DIELECTRIC MATERIALS   [09]

Origin of magnetic moment – Bohr magneton – Dia, Para, Ferro and Anti ferromagnetism and its properties - Domain theory– Hysteresis – soft and hard magnetic materials – applications (Qualitative) – Dielectrics (non conducting materials) - Dielectric constant – Polarization in dielectrics – Electronic, Ionic, Orientational and Space charge polarizations (Derivation for polarizability) – Internal or local field- Clausius - Mosotti equation – Dielectric loss – Applications.

UNIT - IV   ELASTICITY AND HYDRODYNAMICS   [09]

Elasticity – Stress - Strain – Hooke's Law – Types of moduli of elasticity – Torsional pendulum – Determination of Rigidity modulus of a wire – Bending of beams – Expression for bending moment – Measurement of Young's modulus by uniform and non-uniform bending – Viscosity – Stream line flow – Turbulent flow – Poiseuille's equation for the flow of liquid through a tube.

UNIT - V   MODERN ENGINEERING MATERIALS   [09]

Metallic glasses: Preparation, properties and applications – Shape memory alloys (SMA): characteristics, properties of Ni-Ti alloy, applications, advantages and disadvantages – Nanomaterials: synthesis – solgels – pulsed laser deposition – properties and applications - Bio glasses.

Total = 45 Periods

Course Outcomes: On completion of this course, the student will be able to
- C01:   *Perceive the preambles, types of crystals and to conceive the different crystal structures.*
- C02:   *Comprehend the basics of conducting, superconducting materials and their applications.*
- C03:   *Categorize the magnetic materials based on their properties and to enumerate different types of polarization in dielectrics and the theories of dielectrics.*
- C04:   *Grasp the knowledge about different types of elasticity, bending of beams, property of flow of liquids and its theory.*
- C05:   *Confer the properties, preparation and applications of metallic glasses, shape memory alloys and nano materials.*

Text Books :
1.   Dr.G.Senthil Kumar, "Engineering Physics – II", VRB Publishers Pvt. Ltd.(2011).
2.   Dr. P. Mani, "Engineering Physics – I", Dhanam Publications,(2012).

References:
1.   V.Rajendran, "Engineering Physics", Tata McGraw Hill Education Private Ltd, New Delhi,(2011).
2.   Dr. P. Mani, "Engineering Physics – II", Dhanam Publications,(2015).
3.   R. Murugesan, "Properties of matter", S. Chand & Co, Delhi, (2007).
4.   Subramaniam & Brij Lal, "Properties of Matter", S. Chand & Co, New Delhi,(2005).
5.   www.fadooengineers.com.

SEMESTER – II

16CY254　　　　　**ENVIRONMENTAL SCIENCE AND ENGINEERING**　　　　L　T　P　C
　　　　　　　　　　　　　　　　(Common to All Branches)　　　　　　　　　　　　3　0　0　3

Prerequisite: *No Prerequisites are needed for enrolling into the course.*
Objectives:
- *To impart knowledge on the principle of environmental science and engineering.*
- *To understand the usages of natural resources, ecosystem and biodiversity.*
- *To create awareness on pollution, value education, population growth and social issues.*

UNIT - I　　　INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES　　　[09]

Environment – definition, scope and importance, need for public awareness; Forest resources – use, over exploitation, deforestation, mining, dams and their effects on forests and tribal people; Water resources – use, over- utilization of surface and ground water, floods, drought, conflicts over water; Mineral resources – use, exploitation, environmental effects of extracting and using mineral resources ; Food resources - world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity; Role of an individual in conservation of natural resources.

UNIT - II　　　ECOSYSTEMS AND BIODIVERSITY　　　[09]

Concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers, forest ecosystem and aquatic ecosystems (Estuary and marine ecosystem); Food chain, food web, energy flow in the ecosystem, ecological pyramids – ecological succession ; Biodiversity – introduction, definition – types (Genetic – species – ecosystem diversity); Values of biodiversity; Hot-spots of biodiversity; Threats to biodiversity; Endangered and endemic Species of India; Conservation of biodiversity – I*n-situ* and E*x-situ* conservation of biodiversity.

UNIT - III　　　ENVIRONMENTAL POLLUTION　　　[09]

Pollution – introduction and different types of pollution; Causes, effects and control measures of air pollution, water pollution – BOD and COD (definition and significance), DO and its détermination by Winkler's method- waste water treatment methods ; primary, secondary and tertiary treatments. Thermal pollution – noise pollution – nuclear pollution (Nuclear wastes, nuclear accident and nuclear holocaust); Solid waste management – causes, effects and control measures of urban and industrial waste; Hazardous waste –medical and e-wastes.

UNIT - IV　　　SOCIAL ISSUES AND ENVIRONMENT　　　[09]

Urban problems related to energy; Water conservation – rain water harvesting and watershed management; Resettlement and rehabilitation; Environmental ethics – Issues and possible solutions; Climate change – global warming and its effects on flora and fauna, acid rain, ozone layer depletion; Wasteland reclamation ; Environment protection act – air (Prevention and control of pollution) act, Water (Prevention and control of pollution) act, Wildlife protection act and forest conservation act; Issues involved in enforcement of environmental legislation. Disaster Management- earth quake, cyclone, tsunami, disaster preparedness- response and recovery from disaster.

UNIT - V　　　HUMAN POPULATION AND ENVIRONMENT　　　[09]

Sustainable development – from unsustainable to sustainable development – 12 Principles of green chemistry – Environmental impact assessment (EIA) ;Human population – population growth and variation among nations; Population explosion; Family welfare programme and family planning; Environment and human health; Human rights; Value education – HIV / AIDS ; Women and child welfare; Role of information technology in environment and human health.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
　　　　C01: *Play an important role in conservation of resources for future generation.*
　　　　C02: *Paraphrase the importance of ecosystem and biodiversity.*
　　　　C03: *Analyze the impact of pollution and hazardous waste in a global and societal context.*
　　　　C04: *Understand contemporary issues that result in environmental degradation that would attempt to provide solutions to overcome the problems.*
　　　　C05: *Consider issues of environment and human population in their professional undertakings.*

Text Books :
1. Anubha Kaushik and C. P. Kaushik, Environmental Science and Engineering, New Age International Publishers, 14th Edition, 2014.
2. Dr. T. Arun Luiz, Environmental Science and Engineering, S.Chand & Co.Pvt.Ltd.,1st Edition, 2016.

Reference Books :
1. G. Tyler Miller, Jr, Environmental Science,Thomson-South western, 11th Edition, 2007.
2. Raman Sivakumar, Introduction to Environmental Science and Engineering, TMH., 4th Edition 2012.
3. Dara S. S., A Text Book of Environmental Chemistry and Pollution Control, S. Chand & Co., 10th Edition, 2005.

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SEMESTER – II

16ME215	BASIC MECHANICS	L	T	P	C
		3	1	0	4

Prerequisite: *No Prerequisites are needed for enrolling into the course.*
Objective   :

• *To develop the capacity for predicting the effect of force and motion in designing the engineering components.*

UNIT - I   BASICS AND EQUILIBRIUM OF PARTICLES   [12]

Introduction - units and Dimensions - Laws of Mechanics - Lame's Theorem Parallelogram and triangular Law of forces - Coplanar Forces - resolution and composition of forces - Equilibrium of a particle - forces in space - equilibrium of a particle in space - equivalent force systems- principle of transmissibility-single equivalent force.

UNIT - II   EQUILIBRIUM OF RIGID BODIES   [12]

Moment of a force about point -varignon's theorem- Moment of a couple-resolution of force in to force couple system- resultant of coplanar non concurrent system -equilibrium of Rigid bodies in two dimensions. Frictional resistance - classification of friction- laws of friction - coefficient of friction-angle of friction - angle of repose - simple contact friction- Wedge friction, screw friction, rolling resistance, Ladder friction, Belt friction.

UNIT - III   PROPERTIES OF SURFACES   [12]

Properties of sections - area, centroids of lines, areas and volumes, moment of inertia first moment of inertia, second moment of inertia and product moment of inertia, Parallel axis theorem - Perpendicular axis theorem, polar moment of inertia, radius of gyration, mass moment of inertia.

UNIT - IV   DYNAMICS OF PARTICLES   [12]

Kinematics: Rectilinear & Curvilinear motion of particles, displacements velocity and acceleration.
Kinetics: Newton's law, Work Energy method, Impulse and Momentum, Impact of elastic bodies.

UNIT-V   ELEMENTS OF RIGID BODY DYNAMICS   [12]

Translation and rotation of rigid bodies-velocity and acceleration -General plane motion, Absolute motion-relative motion Crank - connecting rod mechanism, Instantaneous centre of rotation.

Total (L : 45 T : 15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to
   C01:   Recall and acquire knowledge in the Law of mechanics, forces and equilibrium of particles.
   C02:   Analyze about moments, couples and equilibrium of rigid bodies in two dimensions and analyze the frictional forces.
   C03:   Determine moment of inertia and centroid using integration methods.
   C04:   Outline the concepts involved in rectilinear and curvilinear motion and summarize the different laws of motion.
   C05:   Analyze the translation and rotation of rigid bodies.

Text Books :
1.   Palanisamy, M.S., Nagan, S. "Engineering Mechanics -Statics and Dynamics", TataMcgraw-Hill(2001).
2.   Natesan, S.C.,"Engineering Mechanics Statics and Dynamics",Umesh Publications ,Naisarak ,Delhi(2005).

Reference Books :
1.   Beer F.P. and Johnson Jr. E.R., "Vector Mechanics for Engineers", Vol. I Statics and Vol. II Dynamics, McGraw-Hill International Edition, 2004.
2.   Rajasekaran, S. and Sankarasubramanian, G., "Engineering Mechanics Statics and Dynamics", 3rdEdition, Vikas Publishing House Pvt. Ltd., (2005).
3.   Irving H. Shames and Krishna MohanaRao. G., "Engineering Mechanics - Statics and Dynamics",4th Edition, Pearson Education (2006).
4.   Hibbeller, R.C. and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition,Pearson Education (2010).
5.   Kumar, K.L., "Engineering Mechanics", 3rd Revised Edition, Tata McGraw-Hill Publishing company, New Delhi (2008).

SEMESTER - II

16EE246	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
	(Common to AU, CE & ME)	3	0	0	3

Prerequisites: *Engineering Mathematics and Engineering Physics.*

Objectives:
- *To study the basic concepts of electric circuits and various measuring instruments.*
- *To familiarize the constructional details and operation of the electrical machines.*
- *To study the special electrical machines.*
- *To study the characteristics of semiconductor devices and its applications.*

UNIT - I   ELECTRICAL CIRCUITS   [09]

Basic Definitions – Ohm's Law – Kirchhoff's Laws – Mesh Analysis – Introduction to AC Circuits: R, RL & RLC series circuits, Average and RMS Value – Power and Power factor for single-phase Circuits – Three-Phase Star and Delta Connections.

UNIT - II   MEASURING INSTRUMENTS   [09]

Basic Methods of Measurements: Direct and Indirect , Functional elements of an instrument – Errors in measurements – Analog and Digital Instruments – Basic Principle of Indicating Instruments – Moving Coil and Moving Iron Ammeter and Voltmeter. Dynamometer type Wattmeter – Induction type Energy Meter – Cathode Ray Oscilloscope.

UNIT - III   DC MACHINES AND TRANSFORMERS   [09]

Faraday's Law – Lenz's Law-Fleming's left hand and right hand rule, DC Generators: Construction –Operation-EMF Equation-Applications, DC Motors: Operation – Types – Characteristics – Applications. Single-Phase Transformer: Construction – Operation – EMF Equation – Classification - Applications.

UNIT - IV   AC MOTORS AND SPECIAL MACHINES   [09]

Single-Phase Induction Motor: Construction – Operation – Split Phase Induction Motor and Capacitor Start Induction Run Motor – Applications, Three-Phase Induction Motor: Construction – Operation – Types – Applications. Special Machines: Stepper Motor – AC Servo Motor.

UNIT - V   ANALOG AND DIGITAL ELECTRONICS   [09]

Semiconductor devices: PN Junction Diode, Zener diode: classification, operation and Characteristics- Bipolar Junction Transistor – CE Configurations and its Characteristics. Review of number systems – digital logic gates – Introduction to Micro processors.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01: Solve the electric circuits by applying basic circuital laws using various combinations of circuit elements.*
- *C02: Illustrate the function of various measuring instruments.*
- *C03: Explain the construction, operating principle and application of DC generator, DC motor, transformers.*
- *C04: Enlighten the construction, operating principle and application of AC motors.*
- *C05: Discuss the characteristics of Diodes, Zener diode, BJT using CE configurations.*

Text Books :
1. Smarajit Ghosh, Fundamentals of Electrical and Electronics Engineering, PHI Learning Private Limited, Second Edition, 2007.
2. V.Jegathesan, K.VinothKumar and R.Saravanakumar, Basic Electrical and Electronics Engineering, Wiley India, First Edition, 2012.

Reference Books :
1. Muthusubramanian,R, Salivahanan S and Muraleedharan K .A, Basic Electrical, Electronics and Computer Engineering,Tata McGraw Hill, Second Edition, 2006.
2. Nagsarkar T K and Sukhija M S,Basics of Electrical Engineering, Oxford University press , Ninth Edition, 2005.
3. Mehta, V.K and Rohit Mehta, Principle of Electrical Engineering, S Chand & Company, Second Edition 2008.
4. Mahmood Nahvi and Joseph A. Edminister, Electric Circuits, Schaum' Outline Series, McGraw Hill, Fifth Edition 2002.

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SEMESTER – II

16GE027	ENGINEERING PRACTICES LABORATORY	L	T	P	C
	(Common to AU, CE, EE & ME)	0	0	3	2

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

GROUP A (CIVIL & MECHANICAL)

Objective:

- *To provide exposure to the students with hands on experience in various basic engineering practices in Civil, Mechanical Engineering.*

LIST OF EXPERIMENTS

1. Study of fitting, carpentry, smithy, sheet metal, foundry, welding, plumbing and machine tools.
2. Make a V joint from the given work pieces using Fitting operation.
3. Make Lap joint / Butt joint / T joint from the given wooden pieces using carpentry tools.
4. Make a Tray/funnel/Cone Model with the given sheet metal.
5. Prepare a mould using solid / split patterns in Foundry.
6. Make a butt joint / lap joint / Tee joints using arc / gas welding equipment.
7. Make a basic / mixed pipe connection for the given layout using plumbing tools.
8. Perform simple Facing and Turning operation using Centre Lathe.
9. Make holes as per the given dimensions using drilling machine.
10. Demonstration on upsetting, swaging and bending operations using smithy tools.

LIST OF EQUIPMENT

1.	Fitting tools and its accessories	-	15 Sets
2.	Carpentry tools and its accessories	-	15 Sets
3.	Smithy tools and Open hearth furnace setup	-	2 Sets
4.	Sheet metal and its accessories	-	15 Sets
5.	Foundry tools and its accessories	-	5 Sets
6.	Arc Welding equipments and its accessories	-	5 Sets
7.	Oxy Acetylene welding setup and its accessories	-	1 Set
8.	Plumbing tools and its accessories	-	15 Sets
9.	Centre Lathe with its accessories	-	2 Nos.
10.	Pillar type drilling machine	-	1 No.

Course Outcomes: On completion of this course, the students will be able to

    C01: Acquire knowledge on plumbing works for water supply and basic pipe connections.
    C02: Learn about the carpentry work practices for planning, sawing and cutting.
    C03: Understand about welding operations like butt joints, lap joints and T – joints.
    C04: Gain the knowledge on basic machining operations in conventional machines.
    C05: Grasp the knowledge on metal forming operations.
    C06: Demonstrate on smithy operations.

GROUP B (ELECTRICAL & ELECTRONICS)

Objectives:

- *To study different types of wiring used in house.*
- *To find the parameter of electrical quantity using different measuring devices.*
- *To study Peak-Peak, RMS value, time period, frequency of AC Signal Parameters using CRO.*
- *To learn different logic gates and its truth tables.*
- *To solder different electronic components.*
- *To build a Half Wave, Full Wave Rectifier using diodes.*

LIST OF EXPERIMENTS

ELECTRICAL ENGINEERING

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 and power factor in RLC circuit.
5. Measurement of energy using single-phase energy meter.

ELECTRONICS ENGINEERING

1. Study of Electronic components and equipments – Resistor colour coding.
2. Measurement of AC signal parameters (Peak-Peak, RMS value, time period, frequency) using CRO.
3. Study of logic gates AND, OR, EX-OR, NOT, Half and Full Adder.
4. Soldering practice – Components Devices and Circuits- Using general purpose PCB.
5. Construction of Half Wave and Full Wave Rectifier.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

C01: *Construct different types of wiring used in house.*
C02: *Estimate the parameter of electrical quantity using different measuring devices.*
C03: *Discover peak-peak, RMS value, time period, frequency of AC Signal Parameters using CRO.*
C04: *Infer different logic gates applications using truth tables.*
C05: *Organize different electronic components.*
C06: *Construct a Half Wave, Full Wave Rectifier using diodes.*

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<u>**SEMESTER - II**</u>

16GE228	**PHYSICS AND CHEMISTRY LABORATORY**	L	T	P	C
	(Common to All Branches)	0	0	3	2

Prerequisites: *Knowledge in Engineering Physics , Chemistry and Materials science.*

Objectives:

- *To gain the practical knowledge and hands on experiences of understanding the physics concepts applied in materials science, properties of matter and solar cell.*

- *To gain knowledge in utilizing electrochemical methods by using analytical equipment and quantitative procedures.*

List of Experiments in Physics Laboratory

1. Determination of Young's modulus of the material of a uniform bar by non – uniform bending method.
2. Determination of Band gap energy of a semiconductor.
3. Determination of Viscosity of a given liquid by Poiseuille's method.
4. Torsional pendulum - Determination of rigidity modulus of a given wire.
5. V-I Characteristics of solar cell   .

List of Experiments in Chemistry Laboratory

1. Conductometric Titration – Strong Acid Vs Strong Base.
2. Conductometric Titration – Mixture of Weak and Strong Acids.
3. Conductometric Titration – Precipitation, $BaCl_2$ Vs Na_2SO_4.
4. Estimation of Ferrous ion by Potentiometry – Fe^{2+} Vs $K_2Cr_2O_7$.
5. Estimation of Hydrochloric Acid by pH metry.
6. Estimation of Iron by Spectrophotometry.

Total = 30 Periods

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

- *C01: Confer the experimental counterparts of materials properties such as modulus, solar cell, and energy gap.*
- *C02: Imbibe the concept of capillary action in fluid dynamics and to compare the coefficient of viscosity of the given liquid.*
- *C03: Gain practical knowledge in determining the strength of a solution in a given solution by conductometric titration methods.*
- *C04: Get conceptual knowledge in estimating the concentration of Iron in solution by electrochemical methods.*
- *C05: Determine the role of pH in quantitative analysis of a solution.*

Text Books :

1. Physics Lab manual, Department of Physics, K.S.R. College of Engineering.
2. Chemistry Lab Manual, Department of Chemistry, K.S.R. College of Engineering.

Reference Books :

1. Dr.G.Senthilkumar, "Physics Lab manual", VRB Publications Pvt. Ltd.,(2006).
2. Advanced Practical Physical Chemistry by J.B. Yadav, GOEL Publishing House.
3. Advanced Practical Inorganic Chemistry by Gurdeep Raj, GOEL Publishing House.

Note:

- **A minimum of five experiments shall be offered in chemistry laboratory.**
- **Laboratory classes on alternate weeks for Physics and Chemistry.**

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<u>SEMESTER – II</u>

16HR251	CAREER DEVELOPMENT SKILLS - I	L	T	P	C
	(Common to All Branches)	-	2	-	-

Prerequisite: No Prerequisites are needed for enrolling into the course.
Objectives   :
- *To help individuals cope with continuous change in the world of work.*
- *To help individuals understand their unique abilities, interests, and aptitudes.*

UNIT - I   SPOKEN ENGLISH   **[06]**

Basic Rules of Grammar – Parts of Speech – Tenses – Verbs-Sentence construction – Vocabulary – idioms & Phrases – Synonyms –Antonyms – Dialogues and Conversation –Exercise(Speaking).

UNIT - II   ESSENTIAL COMMUNICATION   **[06]**

Verbal communication – Effective Communication – Active Listening – Paraphrasing – Feedback, Non Verbal Communication – Body language of Self and Others, Importance of feelings in communication – Dealing with feelings in communication - Practice – Exercise.

UNIT - III   WRITTEN COMMUNICATION – PART 1   **[06]**

Usage of noun, pronoun, adjective (Comparative Forms), Verb, Adjectives, Adverb, Tenses, Articles and Preposition - Change of Voice - Change of Speech - One Word Substitution - Using the same word as different parts of Speech - Odd Man Out - Spelling & Punctuation (Editing).

UNIT - IV   WRITTEN COMMUNICATION – PART 2   **[06]**

Analogies - Sentence Formation - Sentence Completion - Sentence Correction - idioms & Phrases - Jumbled Sentences, Letter Drafting (Formal Letters) - Reading Comprehension (Level 1) – Contextual Usage - Foreign Language Words used in English – Exercise.

UNIT - V   ORAL COMMUNICATION – PART 1   **[06]**

Self Introduction - Situational Dialogues / Role Play (Telephonic Skills) - Oral Presentations - Prepared –'Just A Minute' Sessions (JAM) - Presentation Skills – Exercise.

Total = 30 Periods

Course Outcomes: On completion of this course, the students will be able to
- C01: *Have competent knowledge on grammer with an understanding of its basic tools.*
- C02: *Communicate effectively and enhance interpersonal skills with renewed self confidence.*
- C03: *Construct sentence in English and make Corrections.*
- C04: *Perform oral communication in any formal situation.*
- C05: *Develop their LSRW skills.*

Reference Books :
1.   Anne Laws, "Writing Skills", Orient Black Swan. Hyderabad,2011.
2.   Raj N Bakshmi, "English Grammar Practice", Orient Black Swan., Hyderabad,2009.
3.   Sarah Freeman, "Written Communication in English", Orient Black Swan., Hyderabad,2015.
4.   Thakur K B Sinha,"Enrich Your English "Vijay Nicole.,Chennai,2005.

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<u>**SEMESTER - III**</u>

16MA341	**ENGINEERING MATHEMATICS – III**	L	T	P	C
	(Common to AU, CE, EC & ME)	3	1	0	4

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objectives:

- *To study the concepts of partial differential equations.*
- *To know the basics of Fourier series.*
- *To understand Fourier transforms.*
- *To acquire knowledge in the applications of partial differential equations.*
- *To know the basics of Z–Transforms and solving the difference equation.*

UNIT - I   PARTIAL DIFFERENTIAL EQUATIONS   [12]

Formation of partial differential equations – Lagrange's linear equation – solutions of standard types :
$F(p, q) = 0$; Clairaut's form $z = px + qy + F(p, q)$ – Homogeneous Linear Partial Differential Equations of second and higher order with constant coefficients.

UNIT - II   FOURIER SERIES   [12]

Dirichlet's conditions – General Fourier series - odd and even functions – Half range sine and cosine series – Parseval's theorem – Harmonic analysis.

UNIT - III   FOURIER TRANSFORMS   [12]

Fourier integral theorem (without proof) - Fourier Transform pair – sine and cosine transforms- properties – Transforms of simple functions - Convolution theorem (without proof) – Parseval's identity.

UNIT - IV   APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS   [12]

Classification of Partial Differential Equations – Solutions of one dimensional wave equation – problems on vibrating string with zero and non - zero initial velocity – One dimensional heat equation – problems of steady state condition with zero and non- zero boundary values.

UNIT - V   Z TRANSFORMS AND DIFFERENCE EQUATIONS   [12]

Z-Transforms – Elementary properties – Inverse Z-Transforms by using Partial Fraction method, Convolution theorem (without proof) and Residue theorem – Solutions of difference equations by using Z-Transforms.

Total (L: 45 T:15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Develop the ability in solving partial differential equations.*
- *C02: Apply the basics of Fourier series and its application.*
- *C03: Understand the concepts of Fourier Transforms.*
- *C04: Develop their skills in applications of partial differential equations.*
- *C05: Acquire knowledge in basics of Z–Transforms and solving difference equation by using Z – transform.*

Text Book :

1. Veerarajan.T "Engineering Mathematics", Tata McGraw Hill Publications, New Delhi, (2015).3rd edition.

Reference Books :

1. Bali N. P and Manish Goyal,"Text book of Engineering Mathematics" Laxmi Pub. (P) Ltd. 9th edition, (2011).
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 10th Edition, (2014).
3. Dr. Grewal B.S,"Higher Engineering Mathematics", Tata McGraw Hill Pub. Co, 43rd edition, New Delhi, (2013).

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<u>SEMESTER – III</u>

16ME312	**ENGINEERING THERMODYNAMICS**	L	T	P	C
	(Use of Psychrometric charts, steam tables are permitted)	3	1	0	4

Prerequisites: *Engineering Physics, Engineering Chemistry.*

Objectives:

- *To impart the knowledge on principles of thermodynamics and applying it in analyzing the behaviour of simple physical systems.*
- *To provide in-depth study on thermodynamic relations, Principle of Psychrometry & Properties of pure substances.*
- *To enlighten the basic concepts of vapour power cycles.*

UNIT - I   BASIC CONCEPT AND FIRST LAW   [12]

Basic concepts - concept of continuum, macroscopic approach, Thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics - concept of temperature and heat. Concept of ideal and real gases. First law of thermodynamics - application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipments.

UNIT - II   SECOND LAW   [12]

Second law of thermodynamics - Kelvin's and Clausius statements of second law - reversibility and irreversibility - Carnot theorem, Carnot cycle, reversed Carnot cycle, efficiency, COP - Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase in entropy - availability.

UNIT - III   PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE   [12]

Properties of pure substances - Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam. Calculations for work done and heat transfer in non-flow and flow processes. Standard Rankine cycle, reheat and regenerative cycle.

UNIT - IV   IDEAL AND REAL GASES AND THERMODYNAMIC RELATIONS   [12]

Gas mixtures - properties of ideal and real gases, equation state, Avogadro's Law, Vander Waal's equation of state, compressibility factor, compressibility chart - Dalton's law of partial pressure, exact differentials, T-D relations, Maxwell's relations, Clausius Clapeyron equations, Joule -Thomson coefficient.

UNIT - V   PSYCHROMETRY   [12]

Psychrometry and psychrometric charts, property calculations of air vapour mixtures - Psychrometric processes - Sensible heat exchange processes - Latent heat exchange processes - Adiabatic mixing, evaporative cooling.

Total (L: 45 T:15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Recognize the basic concepts of thermodynamic system, property and first law of thermodynamics.*
- *C02: Apply the concepts of second law of thermodynamics and entropy concepts.*
- *C03: Acquire the knowledge about the basic properties of pure substances and steam power cycles.*
- *C04: Comprehend the applications of thermodynamic properties and their relationship.*
- *C05: Realize the basic properties of Psychrometry and its processes.*

Text Books :

1. Nag.P.K, "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2013.
2. Cengel, 'Thermodynamics - An Engineering Approach' Third Edition - 2003 - Tata McGraw Hill, New Delhi.

Reference Books :

1. Holman.J.P., "Thermodynamics", 3rd Ed. McGraw-Hill, 1995.
2. Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1987.
3. Arora C.P, " Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
4. Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J., Fundamentals of Thermodynamics, 6th ed., John Wiley, 2003.
5. Merala, C., Pother, Craig, W., and Somerton, Thermodynamics for Engineers, Schaum Outline Series, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2004.

		L	T	P	C
16ME313	**FLUID MECHANICS AND MACHINERY**	3	0	0	3

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objectives :

- *To understand the properties of fluid, dynamics of fluids, transport of mass ,momentum and energy.*
- *To gain the applications of the conservation laws to flow through pipes and hydraulics machines are studied.*

UNIT - I   INTRODUCTION   [11]

Units & Dimensions, Properties of fluids - Specific gravity, specific weight, viscosity, compressibility, vapour pressure and gas laws - capillarity and surface tension, Pressure measurement devices, Flow characteristics: types of motion, stream line, path line and streak line, concepts of control volume to continuity equation, energy equation, momentum equation and moment of momentum equations, Bernoulli's equation and its applications.

UNIT - II   FLOW THROUGH CIRCULAR CONDUITS   [07]

Flow though circular conduits and circular annuli, Boundary layer concepts, Hydraulic and energy gradient, Darcy-Weisbach equation, Friction factor and Moody diagram, Minor losses. Flow though pipes in series and in parallel.

UNIT - III   DIMENSIONAL ANALYSIS   [07]

Dimension and units: Buckingham's Π theorem, Dimensionless parameters, Models and similitude, Applications of dimensionless parameters.

UNIT - IV   ROTO DYNAMIC MACHINES   [11]

Homologues units, Specific speed, Elementary cascade theory, Theory of turbo machines- Euler's equation, Hydraulic efficiency, Velocity triangle for single stage radial flow and axial flow machines. Centrifugal pumps, turbines, performance curves for pumps and turbines.

UNIT - V   POSITIVE DISPLACEMENT PUMPS   [09]

Reciprocating pumps, Indicator diagrams, Air vessels. Rotary pumps- Classification, Working principle and performance.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

C01: *Recall about the properties of fluids and determine the pressure using measuring device with the application of Bernoulli's equation discharge can be Calculated.*

C02: *Understand the concept of boundary layer and study of fluid flow through pipes along with Analyze of energy loss in pipes.*

C03: *Apply mathematical techniques in research work for design and to conduct model test and to Design a models on dimensionless parameters.*

C04: *Formulate the performance and analysis of hydraulic turbines and Relate the behavior and performance for turbine under different working conditions.*

C05: *Examine the performance about reciprocating and rotary pumps.*

Text Books :

1. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi, (2015).
2. S K Som, Gautam Biswas, S Chakraborty Introduction to Fluid Mechanics and Fluid Machines (English), 3rd Edition, Mcgraw Hill Education (2011).

References:

1. Rathakrishnan. E, Fluid Mechanics, An Introduction (Third Edition), PHI Learning, Delhi, India, 2012.
2. Ramamritham. S, Fluid Mechanics, Hydraulics and Fluid Machines, Dhanpat Rai & Sons, Delhi, 1988.
3. Kumar. K.L., Engineering Fluid Mechanics (VII Ed.) Eurasia Publishing House (P) Ltd., NewDelhi, 1995.
4. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 1983.
5. http://nptel.ac.in.

SEMESTER – III

16ME314	MANUFACTURING TECHNOLOGY - I	L	T	P	C
		3	0	0	3

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objective:

- *To introduce the students the concepts of metal cutting operations and some basic manufacturing processes and fabrication techniques, such as metal casting, joining and forming processes.*

UNIT - I   THEORY OF METAL CUTTING   [09]

Introduction: material removal processes, types of machine tools - theory of metal cutting: chip formation, orthogonal cutting, cutting force calculations - cutting tool materials, tool wear, tool life, surface finish, cutting fluids.

UNIT - II   CENTRE LATHE   [09]

Centre lathe, constructional features, cutting tool geometry, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation.

UNIT - III   METAL CASTING PROCESSES   [09]

Sand casting - Sand moulds - Type of patterns - Pattern materials - Pattern allowances -   Types of Moulding sand - Properties - Core making - Methods of Sand testing - Moulding machines - Types of moulding machines - Melting furnaces - Working principle of Special casting processes - Shell, investment casting - Ceramic mould - Lost Wax process - Pressure die casting - Centrifugal casting - CO_2 process - Sand Casting defects - Inspection methods.

UNIT - IV   METAL JOINING PROCESSES   [09]

Fusion welding processes - Types of Gas welding - Equipments used - Flame characteristics - Filler and Flux materials - Arc welding equipments - Electrodes - Coating and specifications - Weld defects - Brazing and soldering process - Methods and process capabilities - Filler materials and fluxes- Principle and application of special welding processes - TIG, MIG, submerged arc welding processes.

UNIT - V   METAL FORMING PROCESSES   [09]

Hot working and cold working of metals - Forging process - Types of Forging - Rolling of metals - Principle of wire drawing - Tube drawing - Principles of Extrusion - Types of Extrusion - Hot and Cold extrusion - Sheet metal characteristics - Typical shearing operations, bending and drawing operations - Stretch forming operations.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
  C01:   Build the knowledge about theory of metal cutting.
  C02:   Develop the skills on operations of centre lathe.
  C03:   Gain the knowledge about casting processes.
  C04:   Build the knowledge on metal joining processes.
  C05:   Gain the knowledge on metal forming processes.

Text Books :
1. Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promotors Pvt Ltd., Mumbai, 2008.
2. Gowri, S., Hariharan, P., and Suresh Babu, A., "Manufacturing Technology 1", Pearson Education , 2008.

Reference Books :
1. Magendran, B.S., Parashar & Mittal, R.K., "Elements of Manufacturing Processes", Prentice Hall of India, 2003.
2. Rao, P.N., "Manufacturing Technology",Tata McGraw-Hill Publishing Limited, II Edition, 2009.
3. Sharma, P.C., "A text book of production technology",S. Chand and Company, IV Edition, 2005.
4. Begman, 'Manufacturing Process", John Wilely & Sons, VIII Edition, 2005.
5. Serope Kalpajian, Steven R.Schmid, Manufacturing Engineering and Technology, Pearson Education, Inc. 2010.

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SEMESTER - III

		L	T	P	C
16ME315	**MACHINE DRAWING**	1	0	2	3

Prerequisite: *Engineering Drawing.*

Objectives:

• *To impart the knowledge in machine drawing fundamentals.*
• *To impart the knowledge to study, draw and understand various machine elements.*

PART A (40 Marks)

UNIT - I   I.S. CODE OF PRACTICE FOR ENGINEERING DRAWING   [03]

Use of scales - Selection and designation of sizes - Types of lines - termination of leader line, hatching of sections - revolved and removed sections.

UNIT - II   FASTENERS   [04]

Conventional representation of threads - Internal and external types. Bolts and Nuts - Machine and cap screws, set screws, Grub screws, studs. Types of nuts - cap, castle, wile's, lock nuts - Locking by set screw, grooved nut, plate and spring washer. Hexagonal square bolt and nut assembly.

UNIT - III   BEARINGS   [04]

Sliding contact bearings - Solid and bushed journal, Plummer block - foot step bearing with radial and thrust ball bearing - symbols of antifriction bearings.

UNIT - IV   PULLEYS   [04]

Pulley with arms, pulley with web, step cone pulley for flat belt, Pulley for V-belt, fast and loose pulley.

PART B (60 Marks)

UNIT - V   ASSEMBLY DRAWING   [30]

Sleeve and Cotter joint, Knuckle joint, Flexible coupling, Screw jack, Swivel bearing, Tail stock, Machine vice, Milling fixture, Drilling Jig, Steam stop valve.

Total (L: 15 P: 30) = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

   C01: Gain the knowledge about basic concepts of I.S code for machine drawing.
   C02: Acquire the knowledge about different types of fasteners for machine design.
   C03: Demonstrate the bearing working methods.
   C04: Ensure the principles about the stepped cone pulley for different types of belts.
   C05: *Draw the given assembly drawings.*

Text Book :

1.   Gopalakrishnan, K.R., "Machine Drawing", Subhas publications, Bangalore, Eighteenth edition, 2004.

References :

1.   Narayana, K.L., Kannaiah, P., and Venkata Reddy, K., "Machine Drawing", 3rd reprint, New Age International Ltd., New Delhi, 2003.
2.   Dhawan, "Machine Drawing", First Edition, Sultan Chand and Sons, New Delhi, 1996.
3.   Bhatt, N.D., "Machine Drawing", Wiley Eastern Pvt.Ltd., 1998.
4.   BIS Code 919.
5.   http://nptel.ac.in.

   Note:
   Question paper pattern:
   1(a) or 1(b) – Unit - I   = 10 Marks
   2(a) or 2(b) – Unit - II   = 10 Marks
   3(a) or 3(b) – Unit - III   = 10 Marks
   4(a) or 4(b) – Unit - IV   = 10 Marks
   5(a) or 5(b) – Unit -V   = 60 Marks

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SEMESTER – III

		L	T	P	C
16EE336	**ELECTRICAL DRIVES AND CONTROL**	3	0	0	3

Prerequisite : Basics of Electrical and Electronics Engineering.

Objectives   :

* *To understand the basic concepts of the electrical drives.*
* *To study the different methods of starting and braking of DC and AC motors.*
* *To study the conventional and solid-state DC & AC drives.*
* *To understand the system modeling and control system.*

UNIT - I   INTRODUCTION   [09]

Electrical drives - Need - Advantage of electrical drives - Basic elements of electrical drives - Factors influencing the choice of electrical drives - Four quadrant operation of a motor driving a hoist load - Load torques - Heating and cooling curves - Classes of motor duty - Selection of power rating for drive motors with regard to thermal overloading and load variation factors.

UNIT - II   CHARACTERISTICS OF ELECTRIC DRIVES   [09]

Speed - Torque characteristics of various types of loads and drive motors - DC Motors: DC shunt, DC series, DC compound and Permanent Magnet DC motors - AC Motors: Single phase and three phase Induction motors.

UNIT - III   STARTING AND BRAKING METHODS   [09]

Starting and braking methods of DC Motors - DC motor starters - Starting and braking methods of single phase induction motor - Starting and braking methods of three phase induction motor.

UNIT - IV   SYSTEM MODELING   [09]

Basic elements of control system - Open loop and Closed loop systems - Differential equation - Transfer function, Modeling of electric systems, Translational and rotational mechanical systems.

UNIT - V   CONTROLLERS   [09]

First order systems – impulse and step response – analysis of second order systems – Types of controllers – P, PI and PID – Performance evaluation of closed loop system – Introduction to adaptive controllers, predictive controllers and model reference adaptive controllers.

                                                                   Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

   C01: Describe the structure of electric drive system and the basic requirements of mechanical systems.
   C02: Explain the characteristics of various types of DC Motors and Induction Motors.
   C03: Describe the different starting and braking methods used in the DC and AC Motor drives.
   C04: Explain the modeling of electrical and mechanical systems.
   C05: Implement the different types of controllers in the electrical drives system.

Text Books :

1. Dubey G K, Fundamentals of Electrical Drives, Alpha science international Ltd Publishing, Second Edition, 2001.
2. Nagrath I J and Kothari D P, Electrical Machines, Tata McGraw-Hill, First Edition. 2007.

Reference Books :

1. Nisit K De and Prasanta K Sen, Electric Drives, Prentice Hall Pvt. Ltd, Second Edition, 2006.
2. Bose, B K, Modern Power Electronics and AC Drives, Prentice Hall Pvt. Ltd, Second Edition, 2002.
3. Krishnan R, Electric Motor Drives: Modeling, Analysis and Control, Prentice Hall Pvt. Ltd, First Edition 2001.
4. Singh, M D, Khanchandani, K B, Power Electronics, Tata McGraw-Hill, Third Edition, 2008.

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SEMESTER – III

16ME321	**FLUID MECHANICS AND MACHINERY LABORATORY**	L T P C
		0 0 3 2

Prerequisite : *No Prerequisites are needed for enrolling into the course.*

Objective   :

- *To gain the practical knowledge in the fluid flow performance characteristics.*

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. Flow measurement using Pitot tube.
6. Performance test on centrifugal pump / submergible pump.
7. Performance test on reciprocating pump.
8. Performance test on Gear pump.
9. Performance test on Pelton wheel.
10. Performance test on Kaplan turbine.

Total = 45 Periods

LIST OF EQUIPMENT

1.	Orifice meter setup	- 1 No.
2.	Venturi meter setup	- 1 No.
3.	Rotameter setup	- 1 No.
4.	Pipe Flow analysis setup	- 1 No.
5.	Pitot tube set up	- 1 No.
6.	Centrifugal pump/submergible pump setup	- 1 No.
7.	Reciprocating pump setup	- 1 No.
8.	Gear pump setup	- 1 No.
9.	Pelton wheel turbine setup	- 1 No.
10.	Kaplan turbine setup	- 1 No.

Course Outcomes: On completion of this course, the students will be able to

C01:   Understand the concept to determine Coefficient of discharge of Orifice meter and Venturimeter.
C02:   Demonstrate and calculate the rate of flow using Rota meter.
C03:   Categorize friction factor for a given set of pipes.(Major and Minor Losses).
C04:   Determine measurement of flow using Pitot tube.
C05:   Understand the performance test on Various Pumps (Centrifugal pump, reciprocating pump, Gear pump, etc).
C06:   Discuss the working principle of various turbines and conduct the Performance test on Francis turbine, Kaplan turbine and Pelton wheel.

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<u>**SEMESTER – III**</u>

		L	T	P	C
16ME322	**MANUFACTURING TECHNOLOGY LABORATORY – I**	0	0	3	2

Prerequisite: *Engineering Practices Laboratory.*

Objective   :

• *To gain hands on experience in working of general purpose machine tools and various manufacturing processes.*

LIST OF EXPERIMENTS

1. Study of centre Lathe machine and its accessories.
2. Perform Facing and Step Turning operation of the given mild steel rod using Lathe.
3. Perform Taper Turning operation as per the given dimensions using Lathe.
4. Make a Grooving operation of the given part using Lathe.
5. Perform Drilling and Knurling operation as per the given dimensions using Lathe.
6. Make Boring and Counter Boring operations in the given work piece to the required size using Lathe.
7. Cut a metric thread on the given wok piece to the required dimensions.
8. Machine and make an assembly of the given work pieces as per the given dimensions.
9. Make an Eccentric Turning as per the given dimensions using four jaw chuck in Lathe.
10. Measure the Cutting Force using tool dynamometer and determine the Shear Angle of the chip.

Total = 45 Periods

LIST OF EQUIPMENT

1. Centre Lathe with accessories   -   15 Nos.
2. Tool Dynamometer   -   1 No.

Course Outcomes: On completion of this course, the students will be able to

        C01: Acquire knowledge on machining operations using centre Lathe.
        C02: Grasp the hands on training about facing and turning operations using Lathe.
        C03: Understand about thread cutting on a cylindrical work piece by using Lathe machine tool.
        C04: Gain knowledge about knurling and hole making operations in a cylindrical work piece.
        C05: Make boring and counter boring on a cylindrical work piece by using Lathe machine tool.
        C06: Make special operations like grooving, eccentric and profile turning operation in a cylindrical work piece.

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<u>**SEMESTER – III**</u>

		L	T	P	C
16EE326   **ELECTRICAL DRIVES AND CONTROL LABORATORY**

L   T   P   C
0   0   3   2

Prerequisite: Basics of Electrical and Electronics Engineering.

Objectives:

- *To develop the skill on the electrical and mechanical characteristics of various types of AC and DC motors.*

- *To develop the skill on the speed control of various types of AC and DC motors.*

List of Experiments:

1. Load characteristics of DC shunt motor.
2. Load characteristics of DC series motor.
3. Load characteristics of DC compound motor.
4. Load test on single-phase induction motor.
5. Load test on three-phase squirrel cage induction motor.
6. Load test on three-phase slip ring induction motor.
7. Speed Control of DC shunt motor.
8. Speed control of three phase squirrel cage induction motor (Stator Voltage Control).
9. Speed control of three-phase induction motor using PWM inverter.
10. Study of DC motor starters.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

        C01:   Analyze the performance of AC machines.
        C02:   Examine the performance of DC machines.
        C03:   Employ various speed control methods for DC machines.
        C04:   Employ various speed control methods for AC machines.
        C05:   Explain the functions of various DC motor starters.

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<u>**SEMESTER – III**</u>

16HR352	CAREER DEVELOPMENT SKILLS - II	L	T	P	C
	(Common to All Branches)	-	2	-	-

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objectives:

- *To enhance employability skills and to develop career competency.*
- *To help individuals develop a realistic understanding of themselves in regard to decision making and career alternatives.*

UNIT - I   VERBAL REASONING – PART 1   [06]

Analogies - Alphabet Test - Theme Detection - Family Tree - Blood Relations (Identifying relationships among group of people) - Coding & Decoding - Situation Reaction Test – Statement & Conclusions.

UNIT - II   SPEED MATH'S, QUANTITATIVE APTITUDE   [06]

Think Without Ink(TWI) Approach - Speed Math's: Squaring of Numbers - Multiplication of Numbers - Finding Square Roots - Finding Cube Roots - Solving Simultaneous Equations Faster – Number System: HCF, LCM - Decimals - Percentages - Averages - Powers and Roots - Sudoku (level 1) - Series Completion (Numbers, Alphabets, Pictures) - Odd Man Out – Puzzles.

UNIT - III   QUANTITATIVE APTITUDE – PART 1   [06]

Problem on Ages - Percentages - Profit and Loss - Simple & Compound Interest - Averages - Ratio, Proportion.

UNIT - IV   QUANTITATIVE APTITUDE – PART 2   [06]

Speed, Time & Work and Distance - Pipes and Cisterns - Mixtures and Allegations - Races - Problem on Trains - Boats and Streams Practices : Puzzles, Sudoku, Series Completion, Problem on Numbers.

UNIT - V   WRITTEN COMMUNICATION & READING COMPREHENSION   [06]

What is Writing - Sentence - Phrase - Kinds of Sentences - Parts of Sentence - Parts of Speech – Articles - Types of Sentences - Academic Essay Writing - Precise Writing - Report Abstracts - Letter Writing - Memo - Cover Letter - Resume writing.

READING SKILLS : Importance of Reading - Definition of Reading - Levels of Reading - Requirements of Reading - Types of Reading - Techniques of Reading - Academic Reading Tips – Exercise.

Total = 30 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Speak and write appropriately by understanding and applying the basic grammatical rules.*
- *C02: Demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions.*
- *C03: Enhance their communication skills and instructiveness.*
- *C04: Enhance interpersonal relationship building skills with self-confidence.*
- *C05: Critically evaluate various real life situations by resorting to analysis of key issues and factors.*

Reference Books :

1. Aggarwal, R.S. "A Modern Approach to Verbal and Non-verbal Reasoning", Revised Edition 2008, Reprint 2009, S.Chand & Co Ltd., New Delhi.
2. Abhijit Guha, "Quantitative Aptitude", TMH, 3 edition.
3. Objective Instant Arithmetic by M.B. Lal & GoswamiUpkar Publications.
4. Word Power Made Easy by Norman Lewis W.R. GOYAL Publications.

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SEMESTER - IV

16MA441	**NUMERICAL METHODS**	L	T	P	C
	(Common to AU, CE & ME)	3	1	0	4

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objectives:

- *To study the concepts of polynomial and transcendental equations, simultaneous linear equations.*
- *To acquire knowledge in Interpolation techniques.*
- *To explain numerical differentiation and integration.*
- *To know concepts of numerical solutions to ordinary differential equations*
- *To acquire knowledge in applying numerical solutions to boundary values problems.*

UNIT - I   SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS   [12]

Solutions to polynomials and transcendental equations – Newton's method, Regula-falsi method – Solutions to simultaneous linear equations – Gauss Elimination method – Gauss Jordon method - Gauss-Seidel method – Eigen value of a matrix by Power method.

UNIT - II   INTERPOLATION AND APPROXIMATION   [12]

Newton's forward and backward difference interpolation techniques (equal intervals) – Lagrange's interpolation –inverse Lagranges' interpolation and Divided difference method (for unequal intervals).

UNIT - III   NUMERICAL DIFFERENTIATION AND INTEGRATION   [12]

Numerical differentiation using Newton's forward and backward interpolation methods – Numerical integration by trapezoidal and Simpson's 1/3rd and 3/8th rules – Double integrals using trapezoidal rule and Simpson's rule.

UNIT - IV   INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS   [12]

Solving first order Ordinary Differential Equations by Taylor series– Euler's and Modified Euler's Method – fourth order Runge-Kutta Method – Milne's predictor and corrector method.

UNIT - V   BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS   [12]

Solution of one dimensional heat equation by Bender - Schmidt and Crank - Nicolson method – Solution of One dimensional wave equation – solution of two dimensional Poisson equations.

Total (L:45 T:15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to

    C01: Solve polynomial, transcendental equations and simultaneous linear equations numerically.
    C02: Apply the Interpolation techniques.
    C03: Develop their skills in numerical differentiation and integration.
    C04: Solve ordinary differential equations numerically.
    C05: Understand and apply the concepts of numerical solutions to boundary value problems.

Text Book :

1. Dr. B. S Grewal, "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2010). 9th edition.

Reference Books:

1. Sukhendu Dey and Shishir Gupta "Numerical Methods", Tata Mc Graw Hill Publishing Company, (2013).
2. Dr. M.K. Venkataraman,"Numerical Methods in Science and Engineering", National Publishing Company, (2012), 2nd edition.
3. V. Gerald 'Applied Numerical Analysis' Pearson Education, 6th edition (2012).

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SEMESTER – IV

16ME412	**KINEMATICS OF MACHINERY**	L	T	P	C
		3	1	0	4

Prerequisite: Basic Mechanics.

Objectives:

- *To understand the concept of machines, mechanisms and related terminologies.*
- *To analyse a mechanism for displacement, velocity and acceleration at any point in a moving link.*
- *To understand the theory of gears, gear trains and cams.*
- *To understand the role of friction in drives and brakes.*

UNIT - I   BASICS OF MECHANISMS   **[07]**

Definitions - Link, Kinematic pair, Kinematic chain, Mechanism and Machine - Degree of freedom - mobility - Kutzbach criterion (Gruebler's equation) - Grashoff's law - Kinematic Inversions of four-bar chain and slider crank chain - mechanical advantage - transmission angle.

Description of common mechanisms - offset slider mechanism as quick return mechanisms, Pantograph, straight line generators (Peaucellier and Watt mechanisms), steering gear for automobile, Hooke's joint, Toggle mechanism, Ratchets and escapements - Indexing mechanisms.

UNIT - II   KINEMATIC ANALYSIS   **[15]**

Analysis of simple mechanisms (Single slider crank mechanism and four bar mechanism) - Graphical Methods for displacement, velocity and acceleration; Shaping machine mechanism - Coincident points – Coriolis acceleration - Analytical method of analysis of slider crank mechanism and four bar mechanism. Approximate analytical expression for displacement, velocity and acceleration of piston of reciprocating engine mechanism.

UNIT - III   KINEMATICS OF CAMS   **[11]**

Classifications - Displacement diagrams - Parabolic, Simple harmonic and Cycloidal motions - graphical construction of displacement diagrams and layout of plate cam profiles - circular arc and tangent cams - pressure angle and undercutting.

UNIT - IV   GEARS   **[14]**

Classification of gears – Gear tooth terminology - fundamental law of toothed gearing and involute gearing – length of path of contact and contact ratio - interference and undercutting - Gear trains - simple, compound and Epicyclic gear trains - Differentials.

UNIT - V   FRICTION   **[13]**

Dry friction - Friction in screw jack - Pivot and collar friction - Plate clutches - Belt and rope drives - Block brakes, band brakes.

Total (L: 45 T:15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to

> *C01: Understand the concepts in various mechanisms and pairs.*
> *C02: Perform velocity and acceleration analysis of simple mechanisms.*
> *C03: Design a layout of cam for specified motion.*
> *C04: Explain the principle of gears.*
> *C05: Evaluate the gear terminology of gear trains & the concepts on action of friction.*

Text Books :

1. Khurmi, R. S., "Theory of Machines" S. Chand publications, 2005.
2. Rattan S. S., "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi
   12th reprint 2014.

References:

1. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
2. Ramamurti, V., "Mechanism and Machine Theory", Second Edition, Narosa Publishing House, 2005.
3. Ghosh, A. and Mallick, A. K., "Theory of Mechanisms and Machines", Affiliated East - West Pvt. Ltd., New Delhi, 1998.
4. Rao J.S. and Dukkipati R.V., "Mechanism and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
5. http://nptel.ac.in/video.php?subjectId=112104121.

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SEMESTER – IV

16ME413	STRENGTH OF MATERIALS	L	T	P	C
		3	1	0	4

Prerequisite: Basic Mechanics.

Objectives:

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

UNIT - I   STRESS STRAIN DEFORMATION OF SOLIDS   [12]

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads.

UNIT - II   BEAMS - LOADS AND STRESSES   [12]

Types of beams: Supports and Loads – Shear force and Bending Moment in beams –Cantilever, Simply supported and Overhanging beams – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced – Shear stresses in beams – Shear flow.

UNIT - III   DEFLECTION OF BEAMS   [12]

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method, Macaulay Method, and Moment-area Method –Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns.

UNIT - IV   TORSION   [12]

Analysis of torsion of circular bars – Shear stress distribution – Bars of Solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts – Application to close-coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Deflection of helical coil springs under axial loads – stresses in helical coil springs under torsion loads.

UNIT - V   ANALYSIS OF STRESSES IN TWO DIMENSIONS   [12]

Biaxial state of stresses – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells – Biaxial stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress - Strain energy in bending and torsion.

Total (L: 45 T:15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to
   C01: Acquire knowledge about Rigid, Resistant bodies, stress and stain calculation for steel bars.
   C02: Understand various loads acting on various beams and its application.
   C03: Grasping knowledge about Deflection of beams and Buckingham failure analysis.
   C04: Analyze the solid and hallow shaft by torsional theory.
   C05: Analyze the complex stresses in two dimensions.

Text Books :

1. Bansal R.K., "Strength of materials", Laxmi publications,6th Edition, 2015.
2. Popov E.P, "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi, 3rd Edition, 2004.

References :

1. Nash W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co, New York, 4th Edition,1998.
2. Kazimi S.M.A, "Solid Mechanics", Tata McGraw-Hill Publishing Co., New Delhi, 3rd Edition,2004.
3. Ryder G.H, "Strength of Materials", Macmillan India Ltd., Third Edition, 2002.
4. Ray Hulse, Keith Sherwin & Jack Cain, "Solid Mechanics", Palgrave ANE Books,2004.
5. http://nptel.ac.in/courses/112107147.

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SEMESTER - IV

	L	T	P	C
16ME414 THERMAL ENGINEERING | 3 | 0 | 0 | 3 |

Prerequisite : Engineering Thermodynamics.

Objectives :

- *To integrate the concepts, laws and methodologies from the prerequisite course for analyzing the cyclic processes.*
- *To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems.*

UNIT – I   GAS POWER CYCLES   [09]

Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency - Actual and theoretical PV diagram of four stroke and two stroke engine.

UNIT - II   INTERNAL COMBUSTION ENGINES   [09]

Classification - Components and their function - Valve timing diagram and port timing diagram - Comparison of two stroke and four stroke engines -Carburettor system, Diesel pump and injector system.

Performance calculation - Comparison of petrol and diesel engine - Lubrication system and Cooling system - Battery and Magneto Ignition System - Formation of exhaust emission in SI and CI engines.

UNIT - III   STEAM NOZZLES AND TURBINES   [09]

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow, Impulse and Reaction principles, compounding, velocity diagram for simple and multi-stage turbines, speed regulations – Governors.

UNIT - IV   AIR COMPRESSOR   [09]

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.

UNIT - V   ENERGY RESOURCES   [09]

Definition, Energy Audit- types- steps-Residence, Industries and Institutions- simple calculations- energy saving opportunities - classification and working principle of Non Conventional Energy Sources(NCES), Solar, Wind, Geothermal, Bio-mass, Ozone energy sources, comparison of these energy sources.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01:   Understand the basic concepts of various gas power cycles.*
- *C02:   Get an insight of various components and performance characteristics of an IC engines.*
- *C03:   Gain the knowledge on turbines.*
- *C04:   Evaluate the performance of air compressor.*
- *C05:   Evaluate the energy sources applications.*

Text Books :

1. Rajput, R. K., "Thermal Engineering" S.Chand Publishers , 2010.
2. Kothandaraman, C.P., Domkundwar, S.,Domkundwar, A.V., "A course in Thermal Engineering",Dhanpat Rai &sons, Fifth edition, 2002

Reference Books :

1. Arora, C.P., "Refrigeration and Air Conditioning", Third Edition, Tata McGraw-Hill Publishers, 2014.
2. Ganesan, V., "Internal Combustion Engines" , Fourth Edition, Tata Mcgraw-Hill, 2012.
3. Rudramoorthy, R., "Thermal Engineering", Fourth Edition, Tata McGraw-Hill, New Delhi,2003.
4. Ananthanarayanan, "Basic Refrigeration and Air Conditioning", Tata McGraw-Hill, Fourth edition, 2013.
5. Ramesh, R., Kumar, K.U., "Renewable Energy Technologies", Norosa Publising House, New Delhi, 1997.

SEMESTER – IV

		L	T	P	C
16ME415	**MANUFACTURING TECHNOLOGY – II**	3	0	0	3

Prerequisite: *Manufacturing Technology – I.*

Objectives:

- *To understand the concept, basic mechanics of metal cutting and working of standard machine tools such as lathe, shaping, milling, drilling, grinding, broaching and allied machines.*
- *To understand the basic concepts of computer numerical control (CNC) machine tool and CNC programming.*

UNIT - I   SPECIAL PURPOSE LATHES   [09]

Capstan and turret lathes – automatic lathe - single spindle, Swiss type, automatic screw type, multi spindle - Turret indexing mechanism, Bar feed mechanism.

UNIT - II   RECIPROCATING MACHINE TOOLS, MILLING AND GEAR CUTTING   [09]

Reciprocating machine tools: shaper, planer, slotter – specifications, work holding devices, working principles, mechanisms; Milling: types, Cutters, indexing mechanisms - gear operations – gear cutting, forming, generation, shaping, hobbing.

UNIT - III   SPECIAL PURPOSE MACHINE TOOLS   [09]

Hole making: drilling - Quill mechanism, Reaming, Boring, Tapping; Sawing machine: hack saw, band saw, circular saw; broaching machines: broach construction - push, pull, surface and continuous broaching machines.

UNIT - IV   ABRASIVE PROCESSES AND SUPER FINISHING PROCESSES   [09]

Abrasive processes: grinding wheel - specifications and selection, types of grinding process - cylindrical grinding, surface grinding, centreless grinding - honing, lapping, super finishing, polishing and buffing, abrasive jet machining.

UNIT - V   UNCONVENTIONAL MACHINES   [09]

EDM, WIRE EDM, ECM, EBM, Laser Machining, Water jet Machining - Numerical control (NC) machine tools - CNC: types, constructional details. Part programming fundamentals - manual programming - computer assisted part programming.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01: Gain the knowledge about basic concepts of special purpose lathe.*
- *C02: Build the knowledge about constructional features and types of reciprocating machine tools, milling and gear cutting machines.*
- *C03: Develop the knowledge about utilizing the features of special purpose machines.*
- *C04: Apply the knowledge on abrasive processes and super finishing methods.*
- *C05: Reveal the knowledge of main aspects of the unconventional machining process and create the part program about how to make a component using CNC programming languages.*

Text Books :

1. Hajra Choudry, S. K., "Elements of Work Shop Technology – Vol. II", Media Promoters. 2006.
2. HMT, "Production Technology", Tata McGraw-Hill, 2002.

Reference Books :

1. Rao, P.N., "Manufacturing Technology: Metal Cutting and Machine Tools", Tata McGraw–Hill, New Delhi, 2013.
2. Sharma, P.C., "A Text Book of Production Engineering", S. Chand and Co. Ltd, Fourth edition, 2010.
3. Helmi A. Youssef, Hassan A. El-Hofy, Mahmoud H. Ahmed, "Manufacturing Technology: Materials, Processes, and Equipment", CRC Press, 2011.
4. Nagendra Parashar, B. S., Mittal, R. K., "Elements of Manufacturing Processes", PHI Learning Pvt. Ltd, 2004.

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SEMESTER – IV

16ME416	ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
		3	0	0	3

Prerequisites : Engineering Physics, Applied Physics.

Objective   :

- *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 - I   CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS   [09]

Constitution of alloys - Solid solutions, substitutional and interstitial - phase diagrams, Isomorphous, eutectoid, eutectic, peritectic, and peritectroid reactions, Iron - Iron carbide equilibrium diagram. Classification of steel and cast Iron, microstructure, properties and applications.

UNIT - II   HEAT TREATMENT   [09]

Definition - Full annealing, stress relief, recrystallisation and spheroidizing-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 - carburising, nitriding, cyaniding, carbonitriding, flame and induction hardening.

UNIT - III   MECHANICAL PROPERTIES AND TESTING   [09]

Mechanism of plastic deformation, slip and twinning - Types of fracture - Testing of materials under tension, compression and shear loads - Hardness tests (Brinell, Vickers and Rockwell), Impact test - Izod and Charpy, Fatigue and creep tests, fracture toughness tests.

UNIT - IV   FERROUS AND NON FERROUS METALS   [09]

Effect of alloying elements on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels- Titanium and titanium alloys- HSLA - maraging steels - Cast Irons - Grey, White malleable, spheroidal - Graphite, Alloy cast irons, Copper and Copper alloys - Brass, Bronze and Cupronickel - Aluminum and Al-Cu alloy - precipitation hardening- Bearing alloys.

UNIT - V   NON-METALLIC MATERIALS   [09]

Polymers - types of polymer, commodity and engineering polymers – properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE polymers -urea and phenol formaldehydes – engineering ceramics – introduction to Fibre reinforced plastics.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Develop fundamental concepts of alloys and phase diagrams.*
- *C02: Outline the phase diagrams which are useful for design and control of heat treating processes.*
- *C03: Understand the mechanical properties and testing.*
- *C04: Identify the ferrous and non ferrous metals.*
- *C05: Impart the knowledge on non metallic materials.*

Text Books :

1. Khanna, O.P., "A text book of Materials Science and Metallurgy", DhanpatRai Publications, 2013.
2. Raghavan,V., "Materials Science and Engineering",6th Edition,PHI Learning Pvt. Ltd., 2015.

Reference Books :

1. William D Callister "Material Science and Engineering", John Wiley and Sons 2007.
2. Kenneth G.Budinski and Michael K.Budinski "Engineering Materials", Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.
3. Sydney H.Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 2007.
4. Dieter, G. E., "Mechanical Metallurgy", Mc Graw Hill Book Company, 1988.
5. Rajput,R. K., "Engineering Materials & Metallurgy", S. Chand Limited, 2006.

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SEMESTER - IV

			L	T	P	C
16ME421	**THERMAL ENGINEERING LABORATORY**		0	0	3	2

Prerequisite : Engineering Thermodynamics.

Objective :

- *To gain the knowledge in testing the performance of engines.*

LIST OF EXPERIMENTS

1) Valve Timing Diagram.
2) Port Timing Diagram.
3) Determination of Viscosity – Red Wood Viscometer.
4) Determination of Flash Point and Fire Point.
5) Performance Test on 4-stroke Diesel Engine.
6) Heat Balance Test on 4-stroke Diesel Engine.
7) Morse Test on Multi cylinder Petrol Engine.
8) Retardation Test to find Frictional Power of a Diesel Engine.
9) Performance and Energy Balance Test on a Steam Generator.
10) Performance and Energy Balance Test on Steam Turbine.

Total = 45 Periods

LIST OF EQUIPMENT

1. I.C Engine – 2 stroke and 4 stroke model.	1 set.
2. Red Wood Viscometer.	1 No.
3. Apparatus for Flash and Fire Point.	1 No.
4. 4-stroke Diesel Engine with mechanical loading.	1 No.
5. 4-stroke Diesel Engine with hydraulic loading.	1 No.
6. 4-stroke Diesel Engine with electrical loading.	1 No.
7. Multi-cylinder Petrol Engine.	1 No.
8. Single cylinder Petrol Engine.	1 No.
9. Data Acquisition system with any one of the above engines.	1 No.
10. Steam Boiler with turbine setup.	1 No.

Course Outcomes: On completion of this course, the students will be able to
- C01: *Understand the basic knowledge in relation to Valve timing and Port timing diagram.*
- C02: *Perform the experiment to determine the properties of fuels and oils.*
- C03: *Demonstrate the Performance on engines and draw its characteristics.*
- C04: *Analyze the heat balance on four-stroke diesel engine.*
- C05: *Predict and analyze the performance of multi cylinder petrol engine by energy balance test.*
- C06: *Evaluate the frictional power of a diesel engine using retardation test.*

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SEMESTER – IV

L	T	P	C
0	0	3	2

16ME422   **STRENGTH OF MATERIALS LABORATORY**

Prerequisite: No Prerequisites are needed for enrolling into the course.

Objective   :

- *To supplement the theoretical knowledge with practical testing for determining the strength of materials under externally applied loads. This would enable the student to have a clear understanding of the design for strength and stiffness.*

LIST OF EXPERIMENTS

1. Tension test on a mild steel rod.
2. Double shear test on Mild steel and Aluminum rods.
3. Torsion test on mild steel rod.
4. Impact test on metal specimen.
5. Hardness test on metals - Brinnell Hardness Number.
6. Hardness test on metals - Rockwell Hardness Number.
7. Deflection test on beams.
8. Compression test on ductile materials – helical spring.
9. Tension test on helical spring.
10. Compression test on brittle materials – concrete cubes.

Total = 45 Periods

LIST OF EQUIPMENT

1.	Universal Testing machine with double shear attachment (40 Ton Capacity)	-	1 No.
2.	Torsion Testing Machine (60 NM Capacity)	-	1 No.
3.	Impact Testing Machine (300 J Capacity)	-	1 No.
4.	Brinnell 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.	Deflection testing equipment	-	1 No.
8.	Compression testing machine	-	1 No.

Course Outcomes: On completion of this course, the students will be able to

 C01: Analyze the mechanical properties of materials.
 C02: Examine deflection of simply supported beam.
 C03: Predict the hardness of the different materials.
 C04: Demonstrate torsion tests on ductile materials.
 C05: Analyze the tensile strength of various materials.
 C06: Evaluate the compressive strength for different types of materials.

SEMESTER – IV

		L	T	P	C
16ME423	**MANUFACTURING TECHNOLOGY LABORATORY- II**	0	0	3	2

Prerequisite: *Manufacturing Technology.*

Objective　:

- *To give practical hands on exposure to students in the various metal cutting operations using commonly used machine tools.*

LIST OF EXPERIMENTS

1. Plain Surface Grinding.
2. Drilling, Reaming and Tapping.
3. Keyway Milling.
4. Hexagonal Milling.
5. Assemble the parts using Capston / Turret Lathe.
6. Gear generation in hobbing machine.
7. Cylindrical Grinding.
8. Planning the Surfaces of a Cube.
9. V - Groove Cutting in Shaping Machine.
10. Keyway Cutting in Slotter.

Total = 45 Periods

LIST OF EQUIPMENT

1.	Turret and Capstan Lathes	-	1 No each.
2.	Horizontal Milling Machine	-	1 No
3.	Vertical Milling Machine	-	1 No
4.	Surface Grinding Machine	-	1 No.
5.	Cylindrical Grinding Machine	-	1 No.
6.	Shaper	-	2 Nos.
7.	Slotter	-	1 No.
8.	Planner	-	1 No.
9.	Radial Drilling Machine	-	1 No.
10.	Gear Hobbing Machine	-	1 No.

Course Outcomes: On completion of this course, the students will be able to

　　C01:　Measure the shear angle of a single point cutting tool in a lathe machine.
　　C02:　Apply the knowledge in the manufacturing features using a centre and capstan lathe machines for producing verities of cylindrical jobs.
　　C03:　Demonstrate the experiments in reciprocating machine tools like shaper, slotter and planner.
　　C04:　Create the different types of jobs in machine tools like drilling and milling machine operations.
　　C05:　Develop the knowledge of making the surface grinding of a plate using surface and cylindrical grinding machine.
　　C06:　Apply the knowledge of utilizing the gear hobbing machine to fabricate a spur and helical gears.

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<u>**SEMESTER – IV**</u>

	L	T	P	C

16HR473   **CAREER DEVELOPMENT SKILLS- III**

	-	2	-	-

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objectives:
- *To provide the opportunity for individuals to become acquainted with a wide range of occupational and educational opportunities.*
- *To assist individuals in making appropriate educational and occupational choices.*

UNIT - I   WRITTEN AND ORAL COMMUNICATION – PART 1   [06]

Reading Comprehension Level 3 - Self Introduction - News Paper Review - Self Marketing - Debate- Structured and Unstructured GDs Psychometric Assessment – Types & Strategies to answer the questions Practices: Sentence Completion - Sentence Correction - Jumbled Sentences - Synonyms & Antonyms - Using the Same Word as Different Parts of Speech - Interpretation of Pictorial Representations – Editing.

UNIT - II   VERBAL & LOGICAL REASONING – PART 2   [06]

Syllogism - Assertion and Reasons - Statements and Assumptions - Identifying Valid Inferences - identifying Strong Arguments and Weak Arguments - Statements and Conclusions- Cause and Effect - Deriving Conclusions from Passages - Seating Arrangements Practices: Analogies - Blood Relations - Statement & Conclusions.

UNIT - III   QUANTITATIVE APTITUDE – PART 3   [06]

Probability - Calendar- Clocks - Logarithms - Permutations and Combinations.

UNIT - IV   QUANTITATIVE APTITUDE – PART 4   [06]

Algebra - Linear Equations - Quadratic Equations – Polynomials - Problem on Numbers - Ages - Train - Time and Work - Sudoku – Puzzles.

UNIT - V   DOMAIN PROFICIENCY   [06]

Competitive exam training: Kinematics of Machinery- Strength of Materials- Thermal Engineering- Manufacturing Technology – II- Engineering Materials and Metallurgy.

Total = 30 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01: Understand the nuances of reading various texts.*
- *C02: Perform well in verbal and logical reasoning.*
- *C03: Understand and develop the etiquette necessary to present oneself in a professional setting.*
- *C04: Demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions.*
- *C05: Enhance the technical skills in competitive exams.*

Reference Books :
1. Aggarwal, R.S. "A Modern Approach to Verbal and Non-verbal Reasoning", Revised Edition 2008,Reprint 2009, S.Chand & Co Ltd., New Delhi.
2. Abhijit Guha, "Quantitative Aptitude", TMH, 3 edition.
3. Objective Instant Arithmetic by M.B. Lal & GoswamiUpkar Publications.
4. Word Power Made Easy by Norman Lewis W.R. GOYAL Publications.

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SEMESTER - V

		L	T	P	C
16MA531	**OPERATIONS RESEARCH**	3	1	0	4

Prerequisite: *No Prerequisites are needed for enrolling into the course.*
Objectives:
- *To learn about the optimization techniques for decision making problem.*
- *To understand concepts of Transportation and Assignment problems.*
- *To study the concepts of project scheduling by network analysis.*
- *To enumerate the concepts in stock control models.*
- *To understand the concepts of scheduling and Replacement problems.*

UNIT - I   LINEAR PROGRAMMING PROBLEM   [12]

Introduction – scope and role of OR - phases of OR - limitations of OR - linear programming problem - formulation of linear programming problem - optimum solution by graphical method - simplex method (using slack variables).

UNIT - II   TRANSPORTATION AND ASSIGNMENT PROBLEM   [12]

Transportation Models (Minimizing and Maximizing Cases) – Balanced and unbalanced cases – Initial Basic feasible solution by North West Corner Rule, Least cost and Vogel's approximation methods. Check for optimality by Modified method.
Assignment Models (Minimizing and Maximizing Cases) – Balanced and Unbalanced Cases - Solution by Hungarian method. Travelling Salesman problem.

UNIT - III   NETWORK MODELS   [12]

Network – Fulkerson's rule - construction of a network - critical path method (CPM) - optimistic, pessimistic and most likely time estimates - project scheduling by PERT analysis.

UNIT - IV   INVENTORY MODEL   [12]

Types of Inventory - Deterministic inventory models - EOQ and EBQ models with and without shortages - quantity discount model - Price breaks - probabilistic inventory model.

UNIT - V   REPLACEMENT MODELS AND SEQUENCING   [12]

Replacement of items that deteriorate with time - value of money changing with time - not changing with time - optimum replacement policy - individual and group replacement.
Sequencing problem - assumptions - processing of 'n' jobs in 2 machines, 'n' jobs with 'm' machines.

Total (L: 45 T: 15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to
   C01: *Develop the decision making during the uncertain situations by linear programming approach.*
   C02: *Identify to minimize the Transportation and Assignment cost and maximize the profit in industries.*
   C03: *Develop the network techniques in project scheduling.*
   C04: *Apply inventory control methods to stock controlling and maximizing the profit.*
   C05: *Understand and apply the Replacement and sequencing methods in manufacturing engineering.*

Text Book :
1. P.K. Gupta and Man Mohan "Problems in Operations Research", S.Chand and Co, 12th edition, 2014.
Reference Books :
1. Hira and Gupta "Problems in Operations Research", S.Chand and Co, 2002.
2. Wayne.L.Winston, "Operations research applications and algorithms", Thomson learning, 4th edition 2007.
3. Taha H.A, "Operation Research", Pearson Education sixth edition, 2003.

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SEMESTER – V

16ME512	DYNAMICS OF MACHINERY	L	T	P	C
		3	1	0	4

Prerequisite : Kinematics of Machinery.

Objective　　:

- *To learn about the system of forces acting on bodies, balancing forces, control mechanisms in automotive systems, types of vibration and their effects on bodies.*

UNIT - I　　　　FORCE ANALYSIS　　　　[12]

Introduction to static and dynamic equilibrium - D'Alemberts principle - principle of superposition - turning moment diagram - flywheel - coefficient of fluctuation of energy, speed and mass of flywheel.

UNIT - II　　　　BALANCING　　　　[12]

Static and dynamic balancing - balancing of rotating masses - balancing of single and multi cylinder engines - balancing of reciprocating masses - partial balancing in locomotive engines - V type engines - balancing linkages.

UNIT - III　　　　CONTROL MECHANISMS　　　　[12]

Governors - types - centrifugal governors - gravity controlled and spring controlled centrifugal governors. Characteristics - stability - sensitivity - effect of friction - controlling force. Gyroscopes - gyroscopic forces and torques - gyroscope stabilization - gyroscopic effects in automobiles, ships and airplanes.

UNIT - IV　　　　LONGITUDINAL VIBRATION　　　　[12]

Undamped free vibration of single degree of freedom system - simple pendulum, compound pendulum - springs in series, springs in parallel and combinations. Damped free vibration of single degree of freedom system - types of damping - viscous damping, critically damped, under damped system. Logarithmic decrement. Forced vibration of single degree of freedom system - constant harmonic excitation, steady state vibration, magnification factor, vibration isolation and transmissibility - measurement of forced vibration.

UNIT - V　　　　TRANSVERSE AND TORSIONAL VIBRATIONS　　　　[12]

Transverse vibrations of beams - natural frequency - energy method - Dunkerly's method. Critical speed - whirling of shafts. Torsional systems - natural frequency of two and three rotor systems, equivalent shafts, geared systems, Holzer's method and signature analysis.

Total (L: 45 T:15) = 60 Periods

Course Outcomes: On completion of this course, the students will be able to

　　C01:　Demonstrate an understanding of turning moment diagrams in various applications& skills to design flywheel for an IC Engine.
　　C02:　Execute static and dynamic balancing of high speed rotary and reciprocating machines.
　　C03:　Apply concept of governors and gyroscopic couples on automobiles,ships and airplanes.
　　C04:　Analyze free and forced vibrations of machines, engines and structures.
　　C05:　Evaluate the transverse and torsional vibrations of beams.

Text Books :

1.　Gupta B.V.R, "Theory of Machines", International Publishing House Pvt. Ltd., New Delhi, 2011.
2.　Rattan S.S, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2014.

Reference Books :

1.　Khurmi R. S, and Gupta J.K, "Theory of Machines", PHI Publishers, New Delhi, 2007.
2.　Rao J.S and Dukkipati R.V, "Mechanism and Machine Theory", New Age International, New Delhi, 2014.
3.　Sadhu Singh, "Theory of Machines", Pearson Edition, 2011.
4.　Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw-Hill, Inc., 1995.
5.　Bevan T, "Theory of Machines", Pearson Edition, 2011.

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SEMESTER – V

16ME513	DESIGN OF MACHINE ELEMENTS	L	T	P	C
	(Use of PSG Design Data Book permitted)	3	0	0	3

Prerequisite : *Strength of Materials.*

Objective :

• *To familiarize various steps involved in the Design Process.*

UNIT - I　　　STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS　　　[09]

Introduction to the design process - factors influencing machine design, selection of materials - preferred numbers, fits and tolerances - direct, bending and torsional stress equations - impact and shock loading - principal stresses - eccentric loading - design of curved beams - crane hook and 'c' frame - factor of safety - theories of failure - stress concentration - design for variable loading - Soderberg, Goodman and Gerber relations - fracture mechanics.

UNIT - II　　　DESIGN OF SHAFTS AND COUPLINGS　　　[09]

Design of solid and hollow shafts based on strength, rigidity and critical speed - design of keys, key ways and splines - design of crankshafts - design of connecting rod - design of rigid and flexible couplings.

UNIT - III　　　DESIGN OF TEMPORARY AND PERMANENT JOINTS　　　[09]

Threaded fasteners - design of bolted joints including eccentric loading, knuckle joints, cotter joints - design of welded joints, riveted joints for structures - theory of bonded joints.

UNIT - IV　　　DESIGN OF ENERGY STORING ELEMENTS　　　[09]

Design of various types of springs, optimization of helical springs - leaf springs - design of flywheels considering stresses in rims and arms, for engines and punching machines.

UNIT - V　　　DESIGN OF BEARINGS　　　[09]

Sliding contact and rolling contact bearings - design of hydrodynamic journal bearings, Mckee's equation. Sommerfeld number, selection of rolling contact bearings.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

C01: Analyze the stress and strain on mechanical components and understand failure modes for their parts.
C02: Design power transmission shafts carrying various elements with geometrical features.
C03: Design and analyze permanent joints under concentric and eccentric loading conditions.
C04: Design and analyze coil springs under various loads.
C05: Design and analyze of machine components such as bearings including prediction of their life and failure.

Text Books :

1. Shigley J.E and Mischke C. R., "Mechanical Engineering Design", 7 th Edition, Tata McGraw-Hill , 2004.
2. Bhandari V.B, "Design of Machine Elements", Third Edition, Tata McGraw-Hill Book Co, 2010.

Reference Books :

1. Khurmi R.S & Guptha J.K, "Machine Design" S.Chand & Co, 2005.
2. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.
3. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
4. Ugural A.C, "Mechanical Design - An Integral Approach, McGraw - Hill Book Co, 2004.
5. Robert L. Norton, Machine Design, (4th Edition), Prentice-Hall, 2010.

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SEMESTER – V

16ME514	HEAT AND MASS TRANSFER	L	T	P	C
	(Use of standard heat and mass transfer data book permitted)	3	0	0	3

Prerequisites : *Engineering Thermodynamics, Thermal Engineering.*

Objective :

• *To learn basics of heat transfer and apply the concepts in real world problems in heat transfer field.*

UNIT - I   CONDUCTION   **[09]**

Basic concepts - mechanism of heat transfer - conduction, convection and radiation - Fourier law of conduction - general differential equation of heat conduction - Cartesian and cylindrical coordinates - one dimensional steady state heat conduction - conduction through plane wall, cylinders and spherical systems, composite systems - unsteady heat conduction - lumped analysis - use of Heislers chart.

UNIT - II   CONVECTION   **[09]**

Basic concepts - heat transfer coefficients - boundary layer concept - types of convection - forced convection - dimensional analysis - external flow - flow over plates, cylinders and spheres - internal flow - laminar and turbulent flow - combined laminar and turbulent - flow over bank of tubes - free convection - dimensional analysis - flow over vertical plate, horizontal plate, inclined plate, cylinders and spheres.

UNIT - III   RADIATION   **[09]**

Basic concepts, laws of radiation - Stefan Boltzmann law, Kirchhoff's law - black body radiation - grey body radiation - shape factor algebra - electrical analogy - radiation shields - introduction to gas radiation.

UNIT - IV   HEAT EXCHANGER   **[09]**

Nusselts theory of condensation - pool boiling, flow boiling, correlations in boiling and condensation. Types of heat exchangers - heat exchanger analysis - LMTD method and NTU - effectiveness - overall heat transfer coefficient - fouling factors - extended surfaces.

UNIT - V   MASS TRANSFER   **[09]**

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 = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

     C01: Apply the concept of heat conduction in simple and composite systems.
     C02: Analyze the convective heat transfer concepts.
     C03: Solve radiation heat transfer problems.
     C04: Illustrate heat exchanger applications.
     C05: Explore the mass transfer concepts.

Text Books :

1. Yunus Cengel and Afshin Ghajar, "Heat and Mass Transfer*"*, Tata McGraw-Hill Book ,5th Edition. 2015.
2. P.K. Nag, "Heat and Mass Transfer", Third Edition Tata McGraw-Hill New Delhi, 2011.

References :

1. J. P. Holman. Fundamentals of Heat and Mass Transfer, McGraw-Hill, 2010.
2. Er. R.K. Rajput, Heat and Mass Transfer S. Chand Second Edition, 2011.
3. C.P. Kothandaraman "Fundamentals of Heat and Mass Transfer" Revised Third Edition, New Age International Publishers- 2016.
4. R. Rudramoorthi,K.Mailsamy "Heat and Mass Transfer" Second Edition Pearson Education, 2011.
5. http://nptel.ac.in.

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SEMESTER - V

16IT535   **PROGRAMMING WITH C++ AND JAVA**

L	T	P	C
3	0	0	3

Prerequisite : *Basic Programming Knowledge in C Language.*

Objectives:

- *To develop programming skills using Object Oriented perspective.*
- *To be familiar in handling pointer operation combined with object orientation.*
- *To learn file handling and stream operations.*
- *To know about the packages and interfaces in Java.*
- *To learn to handle classes and exception in programming.*

UNIT - I   INTRODUCTION TO OBJECT ORIENTED PROGRAMMING   [09]

Introduction to OOPs – Procedure Oriented Vs. Object Oriented Programming – Characteristics of OOPs – Programming Basics of C++ – Control Structures – Structures - Functions – Objects and Classes.

UNIT - II   BASICS OF OOP   [09]

Arrays and Strings - Operator Overloading - Inheritance – Pointers – Virtual Functions – Static Vs. Friend Functions

UNIT - III   FILES AND TEMPLATES   [09]

Streams and Files – File Pointers - Multi-file Programs – Templates and Exceptions – Standard Template Library.

UNIT - IV   INTRODUCTION TO JAVA   [09]

Overview of Java – Data Types - Variables and Arrays – Operators – Control Statements - Introducing Classes.

UNIT - V   ESSENTIAL CONCEPTS IN JAVA   [09]

Closer Look at Methods and Classes – Polymorphism - Inheritance – Packages and Interfaces – Exception Handling.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

C01: *Convert a procedure-oriented program into object-oriented program.*
C02: *Write OO programs using object oriented concepts.*
C03: *Solve problems using Files and Templates.*
C04: *Write programs that handle exceptions.*
C05: *Write programs using packages.*

Text Books:

1.   Robert Lafore, "Object Oriented Programming in C++", Galgotia, Fourth Edition. 2014.
2.   Herbert Schildt, "Java The Complete Reference", McGrawHill, Ninth Edition, 2015.

Reference Books:

1.   Paul Deitel, "C++ How to Program", Deitel, Pearson Education, Seventh Edition, 2010.
2.   E Balagurusamy, "Object Oriented Programming with C++", McGrawHill, Sixth Edition, 2013.
3.   Paul Deitel, "Java How to Program", Deitel, Pearson Education, Ninth Edition, 2012.
4.   Joshua Bloch, "Effective Java", Pearson Education, Second Edition, 2012.

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SEMESTER - V

		L	T	P	C
16EC536	**ELECTRONICS AND MICROPROCESSOR**	3	0	0	3

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objectives:

- *To learn the fundamental concepts of semiconductor devices.*
- *To understand the fundamental concepts of Digital Electronics.*
- *To gain knowledge about 8085 Microprocessors and its applications.*

UNIT - I   SEMICONDUCTORS AND RECTIFIERS   [09]

Classification of solids based on energy band theory - Intrinsic semiconductors - Extrinsic semiconductors - PN junction diode: Characteristics - Half wave and full wave rectifiers - Zener diode: Characteristics - Voltage regulator.

UNIT - II   TRANSISTORS AND AMPLIFIERS   [09]

Bipolar junction transistor: Construction and characteristics - CE configuration and characteristics - Transistor biasing: Fixed and voltage divider biasing - Construction and characteristics: FET, SCR and UJT - Concept of feedback: Negative feedback – Application in temperature and motor speed control - Common Emitter Amplifier (Qualitative treatment only).

UNIT - III   DIGITAL ELECTRONICS   [09]

Number system: Binary, Octal, Hexadecimal - Boolean algebra - Logic gates - Half adder and full adder - Flip flops - Shift Registers: SISO, SIPO, PISO, PIPO - Counters: 3-bit Synchronous up & down, 3-bit Asynchronous up & down - A/D conversion: Single slope, Successive approximation - D/A conversion: Binary weighted resistor type.

UNIT - IV   8085 MICROPROCESSOR   [09]

Block diagram of Microcomputer – 8085: Architecture, Pin configuration, Addressing modes, Instruction set and Simple programs using arithmetic and logical operations.

UNIT - V   INTERFACING AND APPLICATIONS OF MICROPROCESSOR   [09]

Basic interfacing concepts - Interfacing of Input and Output devices - Applications of microprocessor: Temperature control, Stepper motor control, Traffic light control - Case study: Mining problem, Turbine monitor using 8085.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Learn the fundamental concepts of semiconductor device.*
- *C02: Understand the various characteristics of amplifiers.*
- *C03: Understand the fundamental concepts of Digital Electronics.*
- *C04: Gain knowledge about 8085 microprocessors.*
- *C05: Design and develop applications using microprocessor.*

Text Books :

1. Milman and Halkias, "Integrated Electronics", Tata McGraw-Hill publishers, 2nd Edition, 2011.
2. Ramesh Goankar, "Microprocessor Architecture", Programming and Applications with 8085", 5th Edition, Wiley Eastern, 2011.

Reference Books :

1. Malvino and Leach, "Digital Principles and Applications", Tata McGraw-Hill, 7th Edition, 2010.
2. Mehta V.K, "Principles of Electronics", S. Chand and Company Ltd., 11th Edition, 2010.
3. Salivahanan S, Suresh Kumar N, Vallavaraj A, "Electronic Devices and Circuits", TMH, 2nd Edition, 2011.
4. Krishna Kant, "Microprocessors and Microcontrollers", PHI Learning Private Ltd., 2011.

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SEMESTER – V

	L	T	P	C

16ME521   **DYNAMICS OF MACHINERY LABORATORY**

L T P C
0 0 3 2

Prerequisites: *Kinematics of Machinery, Dynamics of Machinery.*

Objective :

- *To experiment and learn the concepts and theories of machines.*

LIST OF EXPERIMENTS

1. Bifilar suspension system - determination of mass moment of inertia of an object.
2. Governors - determination of sensitivity, effort, etc. for Watt, Porter and Proell.
3. Cam - determination of jump speed and profile of the cam.
4. Motorized gyroscope - verification of laws - determination of gyroscopic couple.
5. Whirling of shaft - determination of critical speed of shaft with concentrated loads.
6. Balancing of rotating masses.
7. Determination of moment of inertia by oscillation method for connecting rod and flywheel.
8. Vibrating system - spring mass system - determination of damping co-efficient of single degree of freedom system.
9. Determination of moment of inertia for compound pendulum.
10. Transverse vibration - free beam - determination of natural frequency and deflection of beam.

Total = 45 Periods

LIST OF EQUIPMENT

1.	Whirling speed of shaft setup	1 No.
2.	Free beam setup	1 No.
3.	Cantilever beam apparatus	1 No.
4.	Vibrating table	1 No.
5.	Universal Governor	1 No.
6.	Gyroscope	1 No.
7.	Balancing of rotating masses setup	1 No.
8.	Cam Analyzer	1 No.
9.	Spring mass system	1 No.
10.	Bifilar suspension	1 No.
11.	Compound pendulum	1 No.
12.	Axle setup	1 No.
13.	Turn table apparatus	1 No.

Course Outcomes: On completion of this course, the students will be able to
    C01: Attain basic knowledge about mass moment of inertia on different mechanical setup.
    C02: Apply concept of governors and gyroscopic couple.
    C03: Understand dynamic balancing of rotating masses.
    C04: Analyze the characteristics of different control mechanisms.
    C05: Understand the free response of single degree of freedom systems.
    C06: Measure vibrations, vibration characteristics and understand various methods of vibration control for real life problem.

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SEMESTER - V

		L	T	P	C
16ME522	**HEAT AND MASS TRANSFER LABORATORY**	L	T	P	C
	(Use of standard heat and mass transfer data book permitted)	0	0	3	2

Prerequisites : *Engineering Thermodynamics, Thermal Engineering.*

Objective   : To understand all the 3 modes of heat transfer, namely conduction, convection and radiation practically.

LIST OF EXPERIMENTS

1. Thermal conductivity measurement by guarded plate method.
2. Thermal conductivity of pipe insulation using lagged pipe apparatus.
3. Natural convection heat transfer from a vertical cylinder.
4. Forced convection inside tube.
5. Heat transfer from pin-fin (natural & forced convection modes).
6. Determination of Stefan-Boltzmann constant.
7. Determination of emissivity of a grey surface.
8. Effectiveness of Parallel/counter flow heat exchanger.
9. Determination of COP of a refrigeration system.
10. Experiments on air-conditioning system.

Total = 45 Periods

LIST OF EQUIPMENT

1.	Guarded plate apparatus	1 No.
2.	Lagged pipe apparatus	1 No.
3.	Natural convection-vertical cylinder apparatus	1 No.
4.	Forced convection inside tube apparatus	1 No.
5.	Pin-fin apparatus	1 No.
6.	Stefan-Boltzmann apparatus	1 No.
7.	Emissivity measurement apparatus	1 No.
8.	Parallel/counter flow heat exchanger apparatus	1 No.
9.	Refrigeration test rig	1 No.
10.	Air-conditioning test rig	1 No.

Course Outcomes: On completion of this course, the students will be able to
C01: Find the thermal conductivity in different materials by using lagged pipe and guarded plate apparatus.
C02: Calculate the heat transfer coefficient in natural and forced convection apparatus.
C03: Acquire the basic knowledge of Radiation.
C04: Understand the basic concepts of heat exchangers and applications.
C05: Understand the basics of refrigeration and air-conditioning and find their C.O.P.
C06: Troubleshoot existing engineering heat transfer systems and develop alternatives and more energy efficient systems.

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<u>**SEMESTER – V**</u>

16EC526	**ELECTRONICS AND MICROPROCESSOR LABORATORY**	L	T	P	C
		0	0	3	2

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objectives:
- *To familiarize the characteristics of semiconductor devices.*
- *To perform the logical operations of logic circuits.*
- *To gain the programming knowledge of 8085 microprocessor.*

LIST OF EXPERIMENTS

ELECTRONICS

1. V-I Characteristics of PN Junction and Zener diode.
2. Transistor characteristics in Common Emitter mode.
3. Study of UJT characteristics.
4. Study of Logic gates and verification of their truth tables.
5. Design and implementation of Half-adder and Full adder using logic gates.

MICROPROCESSOR

6. Programming with 8085 microprocessor for the following
   (i) 8-bit Addition.
   (ii) 8-bit Subtraction.
   (iii) 8-bit Multiplication.
   (iv) 8-bit Division.
7. Programming with 8085 microprocessor for finding Maximum and Minimum number in a block of data.
8. Programming with 8085 microprocessor for transferring a block of data from one block to another block.
9. Programming with 8085 microprocessor for Code Conversion.
10. Stepper motor interfacing in 8085 Microprocessor.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
   C01: *Understand the fundamentals of operation of the main semiconductor electronic devices.*
   C02: *Study about different the characteristics of semiconductor electronic devices.*
   C03: *Understand the fundamental concepts of Digital Electronics.*
   C04: *Execution of various programs for arithmetic and logical operations using 8085 microprocessor.*
   C05: *Design and develop the programming for various interfacing devices like stepper motor and traffic light control.*

SEMESTER - V

16HR574	CAREER DEVELOPMENT SKILLS- IV	L	T	P	C
		-	2	-	-

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objectives:

- *To help individuals in retaining valued students as they get to know about their skills and competencies and future aspirations as well.*

- *To help individuals develop a realistic understanding of themselves in regard to decision making and career alternatives.*

UNIT - I   WRITTEN AND ORAL COMMUNICATION – PART 2   [06]

Self Introduction – GD - Personal Interview Skills Practices on Reading Comprehension Level 2 – Paragraph Writing - News paper and Book Review Writing - Skimming and Scanning – Interpretation of Pictorial Representations - Sentence Completion - Sentence Correction - Jumbled Sentences - Synonyms & Antonyms - Using the Same Word as Different Parts of Speech – Editing.

UNIT - II   QUANTITATIVE APTITUDE - PART 5   [06]

Geometry - Straight Line – Triangles – Quadrilaterals – Circles – Co-ordinate Geometry – Cube – Cone – Sphere.

UNIT - III   DATA INTERPRETATION AND ANALYSIS   [06]

Data Interpretation based on Text – Data Interpretation based on Graphs and Tables. Graphs: Column Graphs, Bar Graphs, Line Charts, Pie Chart, Graphs representing Area, Venn Diagram & Flow Charts.

UNIT - IV   RESUME WRITING & PRESENTATION SKILLS   [06]

An Introduction to the Resume - Types of Resumes - Common Resume Errors - Anatomy of a Resume - What Is a Cover Letter? - Types of Cover Letters - Enhancing the Language and Style of Your Resume and Cover Letter - Assessment.
Presentation Skills: Oral presentation and public speaking skills; business presentations. - Understand The Situation - Know Your Tools - Know Yourself - Organize It, Write the Script – Practice - Delivering a Presentation.

UNIT - V   DOMAIN PROFICIENCY   [06]

Competitive exam training: Dynamics of Machinery- Design of Machine Elements- Heat and Mass Transfer.

Total = 30 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Perform well in interview type situations.*
- *C02: Understand the Quantitative Aptitude problems in geometry.*
- *C03: Understand the data interpretation and analysis by using various graphs.*
- *C04: Enhance the skills in resume writing and presentation.*
- *C05: Enhance the technical skills in competitive exams.*

Reference Books :

1. Aggarwal, R.S. "A Modern Approach to Verbal and Non-verbal Reasoning", Revised Edition 2008,   Reprint 2009, S.Chand & Co Ltd., New Delhi.

2. Abhijit Guha, "Quantitative Aptitude", TMH, 3 edition.

3. Objective Instant Arithmetic by M.B. Lal & Goswami Upkar Publications.

4. Word Power Made Easy by Norman Lewis W.R. GOYAL Publications.

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SEMESTER - VI

16ME611	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
	(Use of PSG Design Data Book permitted)	3	0	0	3

Prerequisite : *Design of Machine Elements .*

Objective   :

- *To learn the principles and procedure for the design of power transmission components.*

UNIT – I   FLEXIBLE TRANSMISSION ELEMENTS   [09]

Introduction to transmission systems - design of flat belts, V-belts and pulleys - design of chains and sprockets.

UNIT - II   SPUR AND HELICAL GEARS   [09]

Spur gear terminology - speed ratios and number of teeth - force analysis - tooth stresses - dynamic effects - fatigue strength - factor of safety - gear materials - module and face width - power rating calculations based on strength and wear considerations - design of spur gears. Design of helical gears - pressure angle in the normal and transverse plane - equivalent number of teeth - forces and stresses - estimating the size of the helical gears.

UNIT - III   BEVEL AND WORM GEARS   [09]

Design of Straight and spiral bevel gear-Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight and spiral bevel gears. Design of Worm Gear- Merits and demerits - terminology. Thermal capacity, materials-forces , stresses, efficiency, estimating the size of the worm gear pair.

UNIT - IV   GEAR BOXES   [09]

Geometric progression - standard step ratio - ray diagram, kinematics layout - design of sliding mesh gear box -constant mesh gear box - design of multi speed gear box.

UNIT - V   CLUTCHES AND BRAKES   [09]

Design of plate clutches – axial clutches - cone clutches - internal expanding rim clutches – types of brakes and their applications – design of internal and external shoe brakes.

                                                                Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01:   Learn about the transmission elements and understanding the design and types of belt.*
- *C02:   Identify the specification and to design the spur and helical gear.*
- *C03:   Design bevel and worm gear by identifying the requirements.*
- *C04:   Create the gear boxes according to step ratio using ray diagrams.*
- *C05:   Select and design of clutches and brakes by identifying the requirements.*

Text Books :
1.   Sundararajamoorthy T.V., Shanmugam N, "Machine Design", Anuradha Publications, chennai, 2007.
2.   Khurmi R.S & Guptha J.K, "Machine Design" S. Chand &Co, 2005.

References :
1.   Shigley J.E and Mischke C. R., "Mechanical Engineering Design", McGraw-Hill International Editions, 1989.
2.   Robert L. Mott, "Machine Elements in Mechanical Design",4 Ed, Prentice Hall,2003.
3.   Bhandari, V.B., "Design of Machine Elements", Tata McGraw-Hill Publishing Company Ltd., 1994.
4.   Stephen P. Radzevich, "Dudley's Handbook of practical Gear Design and Manufacture", 2nd Edition, CRC Press, 2012.
5.   http://nptel.ac.in.

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<u>**SEMESTER - VI**</u>

		L	T	P	C
16ME612	**COMPUTER AIDED MANUFACTURING**	3	0	0	3

Prerequisites : Manufacturing Technology –I ,Manufacturing Technology-II.

Objective   :

• *To understand the fundamentals of CNC machines, constructional features and Part Programming.*

UNIT - I   CAD / CAM INTERFACE   [09]

Current trends in manufacturing engineering - design for manufacturing, assembly - process planning techniques - total approach to product development - concurrent engineering - rapid prototyping - Introduction to CAD / CAM software packages.

UNIT - II   FUNDAMENTALS OF CNC MACHINES   [09]

CNC technology - functions of CNC control in machine tools - classification of CNC systems - contouring system - interpolators, open loop, closed loop CNC systems - CNC controllers, hardware features - direct numerical control (DNC Systems). Five axis CNC machines – horizontal / vertical machining center - cycle time reduction.

UNIT - III   CONSTRUCTIONAL FEATURES OF CNC MACHINES   [09]

Design considerations of CNC machines for improving machining accuracy - structural members - slide ways - side linear bearings - ball screws - spindle drives, feed drives - work holding devices, tool holding devices - automatic tool changers. Feedback devices - principles of operation - machining centres - tooling for CNC machines.

UNIT - IV   PART PROGRAMMING FOR CNC MACHINES   [09]

Numerical control codes - standards - manual programming - canned cycles, subroutines - computer assisted programming, CAD / CAM approach to NC part programming - APT language, machining from 3D models.

UNIT - V   COMPUTER AIDED PROCESS PLANNING AND DATA BASE FOR CAM   [09]

Process planning - role of process planning in CAD / CAM integration - approaches to computer aided process planning - variant approach, generative approaches - group technology. 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. Emerging challenges in CAD / CAM, product data management - product modeling - assembly modeling - tolerance modeling.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
  C01: *Understand the various current trends in manufacturing process.*
  C02: *Apply the concepts of CNC machine tools.*
  C03: *Analyze the constructional features of CNC machines.*
  C04: *Understand the concepts of numerical code, manual part programming.*
  C05: *Evaluate the concepts of PDM and Database management systems.*

Text Books :

1. Radhakrishnan P, "Computer Numerical Control ", New Central Book Agency, 1992.
2. Mikell P Groover, "Automation, Production Systems and computer integrated manufacturing", Pearson Education, 2007.

Reference Books :

1. Yoram Koren, "Computer Control of Manufacturing Systems", McGraw-Hill Book Company, 2005.
2. Mahon and J. Browne, "CAD / CAM", Addison - Wesley, 2005.
3. Smith G.T, "CNC - Machining, Techniques - Vol. 1, 2 & 3", verlag, 1992.
4. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall of India Ltd., 1999.

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<u>SEMESTER – VI</u>

16ME613	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
	(Use of psychrometric chart, steam, Refrigeration and air conditioning tables permitted)	3	0	0	3

Prerequisites : *Engineering Thermodynamics, Thermal Engineering , Heat and Mass Transfer.*

Objective   :

- *To learn the basics of refrigeration and air conditioning this can be applied in the real world problems.*

UNIT - I   REFRIGERATION CYCLE   [09]

Review of thermodynamic principles of refrigeration. Concept of aircraft refrigeration system - vapour compression refrigeration cycle - use of p-h charts - cascade system - COP comparison. Vapor absorption refrigeration system. Ammonia water and lithium bromide water systems. Steam jet, solar refrigeration systems.

UNIT - II   REFRIGERANTS AND SYSTEM COMPONENTS   [09]

Compressors - reciprocating & rotary (elementary treatment.) - condensers - evaporators - cooling towers. Refrigerants - properties - selection of refrigerants - eco friendly refrigerants - refrigeration plant controls - testing and charging of refrigeration units - balancing of system components. Applications to refrigeration systems - ice plant - food storage plants - milk - chilling plants - refrigerated cargo transports.

UNIT - III   AIR CONDITIONING   [09]

Air conditioning equipments - air cleaning and air filters - humidifiers - dehumidifiers - air washers condenser - cooling tower and spray ponds - elementary treatment of duct design - air distribution system. Thermal insulation of air conditioning systems - applications: car, industry, stores and public buildings.

UNIT - IV   PSYCHROMETRY AND COOLING LOAD CALCULATION   [09]

Psychrometric processes - use of psychrometric charts - grand and room sensible heat factors - bypass factor - requirements of comfort air conditioning. Types of load - design of space cooling load - heat transmission through building. Solar radiation infiltration - internal heat sources (sensible and latent) - outside air and fresh air load - estimation of total load.

UNIT - V   CRYOGENIC REFRIGERATION SYSTEM   [09]

Cryogenics- definition, Joule Thomson(J-T) effect, Joule Thomson system, Cascade or pre-cooled joule-Thomson refrigeration systems, Philips refrigerators, Gifford- McMahon refrigeration systems, COP,FOM, regenerators and pulse tube refrigerators.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01: Understand the various refrigeration cycles and their applications.*
- *C02: Acquire the basic knowledge on types of refrigerants and refrigeration system components.*
- *C03: Study about the air conditioning equipments and their applications.*
- *C04: Estimate the cooling load by using various parameters and using the psychrometric chart.*
- *C05: Learn about the basic concepts of cryogenic refrigeration system.*

Text Books :

1. Arora. C.P., "Refrigeration and Air Conditioning", Tata McGraw-Hill New Delhi, 2009.
2. Barron, "Cryogenic systems", McGraw Hill Book Co., 1996.

References:

1. Roy J Dossat, "Principles of Refrigeration", Pearson Education 2011.
2. WF Stocker and JW Jones, "Refrigeration and Air Conditioning", McGraw-Hill, 2003.
3. Timmerhaus**,** Klaus D, Flynn**,** Thomas M "Cryogenic process Engineering" Springer,1989.
4. Sapali SN, "Refrigeration and Air Conditioning", PHI Learning Private Ltd, 2009.
5. http://nptel.ac.in

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SEMESTER - VI

| 16ME614 | QUALITY, RELIABILITY AND MAINTENANCE ENGINEERING | L
3 | T
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3 |

Prerequisites :   *Manufacturing technology –I ,Manufacturing Technology-II.*

***Objective*   :**

- *To learn about the quality, reliability, principles and practices of maintenance planning, maintenance policies, repair methods.*

UNIT - I   PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING   [09]

Basic principles of maintenance planning - objectives and principles of planned maintenance activity - importance and benefits of sound maintenance systems - reliability, machine availability - MTBF, MTTR and MWT - factors of availability - maintenance organization - maintenance economics.

UNIT - II   MAINTENANCE POLICIES - PREVENTIVE MAINTENANCE   [09]

Maintenance categories - comparative merits of each category - preventive maintenance, maintenance schedules, repairs cycle - principles, methods of lubrication - TPM.

UNIT - III   CONDITION MONITORING   [09]

Condition monitoring - cost comparison with, without CM - on-load testing, off - load testing - methods, instruments for CM - temperature sensitive tapes - pistol thermometers - wear - debris analysis.

UNIT - IV   REPAIR METHODS FOR BASIC MACHINE ELEMENTS   [09]

Repair methods for beds, sideways, spindles, gears, lead screws and bearings - failure analysis - failures and its development - logical fault location methods - sequential fault location.

UNIT - V   REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT   [09]

Repair methods for material handling equipment - equipment records - job order systems - use of computers in maintenance.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01: Illustrate the principles of maintenance planning and activity in industries.*
- *C02: Analyze maintenance categories and preventive maintenance.*
- *C03: Understand condition monitoring techniques and temperature measuring devices.*
- *C04: Analyze failure methods for machine elements and models.*
- *C05: Analyze repair methods for material handling equipments and maintenance in computers.*

Text Books :

1. Srivastava SK, "Industrial Maintenance Management", S. Chand and Co., 2002.
2. Bhattacharya SN, "Installation, Servicing and Maintenance", S. Chand and Co., 2006.

Reference Books :

1. Mishra RC and Pathak K, "Maintenance Engineering and Management" Prentice Hall of India Pvt. Ltd. 2007.
2. Higgins L.R, "Maintenance Engineering Hand book", McGraw Hill, 5th Edition, 2001.
3. Garg M.R,"Industrial Maintenance", S. Chand & Co., 1986.
4. White E.N, "Maintenance Planning", I Documentation, Gower Press, 1979.

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SEMESTER – VI

	L	T	P	C
16ME621　　**COMPUTER AIDED DESIGN AND MANUFACTURING LABORATORY**	0	0	3	2

Prerequisites: *Manufacturing Technology –I Laboratory, Manufacturing Technology –II Laboratory.*

Objectives:

- *To gain practical experience in handling 3D modeling software systems.*
- *To understand the concepts G and M codes and manual part programming.*

LIST OF EXPERIMENTS

1. 3D modeling and assembly of Knuckle joint.
2. 3D modeling and assembly of Plummer block.
3. 3D modeling and assembly of Screw jack.
4. 3D modeling and assembly of Flange coupling.
5. 3D modeling and assembly of Stuffing box.
6. Part programming for Turning and Facing.
7. Part programming for Threading and grooving.
8. Part programming for Contour milling.
9. Part programming using Mirroring.
10. Part programming for Rectangular pocketing.

Total = 45 Periods

LIST OF EQUIPMENT

1.	Computer server	1 No.
2.	CNC milling trainer type machine with standard accessories	1 No.
3.	CNC lathe trainer type machine with standard accessories	1 No.
4.	Computer system	30 Nos.
5.	EDGE CAM software	30 LICENSES
6.	Solid works/Pro-E /CATIA software	30 LICENSES
7.	HP laser jet printer 1020	1 No.

Course Outcomes: On completion of this course, the students will be able to

- *C01:　Develop the 3D modeling of knuckle joint and plummer block assembly.*
- *C02:　Develop the 3D modeling of screw jack and flange coupling assembly.*
- *C03:　Develop the 3D modeling of stuffing box assembly.*
- *C04:　Learn the part programming for turning and facing operation.*
- *C05:　Implement the part programming for threading and grooving operation.*
- *C06:　Design the part programming for contour milling, mirroring and Rectangular pocketing.*

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SEMESTER- VI

		L	T	P	C
16ME622	**COMPREHENSION AND TECHNICAL PRESENTATION**	0	2	0	1

Prerequisites : *Design, Thermal, Production, Mathematics courses.*

Objective　　:

- *To provide opportunity for the student to revise the fundamental knowledge acquired during the earlier semesters.*

COMPREHENSION

- **Evaluation Procedure**

Test Number	Subject Area	Maximum Marks	Duration (Minutes)
1	Mathematics and Thermal Engineering	50	120
2	Manufacturing , Design and Management	50	120
3	From all the above topics	100	180
End Semester Exam	From all the above topics	100	180

TECHNICAL PRESENTATION

- The students have to refer the journals and conference proceedings and collect the published literature.
- By mutual discussions with the faculty in-charge the student can decide a topic in general.
- The student is expected to collect at least 20 such research papers published in the last 5 years.
- Using OHP/Power Point, the student has to make presentation for 20 minutes followed by 10 minutes discussion.
- The student has to make five presentations in the semester.
- The student has to write a technical report for about 30 - 50 pages (Title page, One page Abstract, Review of Research paper under various sub - headings, concluding remarks and list of references). The technical report has to be submitted to the HOD one week before the final presentation, after the approval of the faculty in-charge.

Total= 30 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01:　Identify the problems in general area of interest by the student.*
- *C02:　Understand the area / problem by referring journals, conference proceedings etc.*
- *C03:　Enhance the collective skills between theoretical knowledge and real time problems.*
- *C04:　Gain knowledge on the problem by presentation and review.*
- *C05:　Acquire idea on report writing and presentation.*

Text Books:
1. "Mechanical Engineering for competitions", R.K jain , Khanna publications.2012.
2. Bansal R.K.,"Mechanical Engineering", Laxmi Publications, 2005.

Reference Book:
1. Anthony G.Atkins, Tony Atkins and Marcel Escudier, "Dictionary for Mechanical Engineering", Oxford Press.

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SEMESTER – VI

		L	T	P	C
16ME623	**INDUSTRY INTERNSHIP AND PROJECT PHASE - I**	0	0	3	2

Prerequisites : *Design, Thermal and Production courses.*

Objective   :
- *To prepare students to gain confidence in solving real time Engineering problems.*

PART-A (50 MARKS) **1 CREDIT**

INDUSTRIAL TRAINING

1.	Industrial Internship for 3 weeks (in the level of MNC / NC (20 Marks) / Industry (10 Marks))	20 Marks
2.	Review /Presentation	20 Marks
3.	Report about the internship with Certificate attached.	10 Marks

PART-B (50 MARKS) **1 CREDIT**

PROJECT

1.	Literature Review (Patents, National Conference, National Journal, International conference, international journal (min 5 in each))	15 Marks
2.	Summary of literature, identification of problem	10 Marks
3.	Review/Paper publications	15 Marks
4.	Report	10 Marks

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
 C01: Identify real time problems.
 C02: Acquire knowledge on the industrial oriented projects.
 C03: Collect the data from the literature surveys and find out the solutions.
 C04: Select the topic based on the critical problems identified.
 C05: Summarize the problems identified and can be compared with the legal requirements.
 C06: Apply the solutions for the problems identified.

SEMESTER – VI

		L	T	P	C
16HR675	**CAREER DEVELOPMENT SKILLS - V**	-	2	-	-

Prerequisite: No Prerequisites are needed for enrolling into the course.

Objectives:

- *To assist individuals in making appropriate educational and occupational choices.*
- *Discuss the importance of using effective action words, keywords, and positioning for a resume, describe how to showcase one's professional skill sets in a cover letter, and perform these tasks.*

UNIT - I   WORLD OF TEAMS   **[06]**

Self Enhancement – Importance of developing assertive skills – developing self confidence – developing emotional intelligence, Importance of Teamwork – Team Vs Group – Attributes of a Successful team – Barriers involved, Working with groups – Dealing with people –Group Decision Making.

UNIT - II   INTERVIEW,GD & PRESENTATION SKILLS   **[06]**

Interview handling skills – self preparation checklist – Grooming tips: do's and don'ts – mock interview & feedback,GD Skills – understanding the objective and skills tested in a GD – General types of GD – Roles in a GD - do's and don'ts – Mock GD & Feedback – Practice.

UNIT - III   RESUME WRITING   **[06]**

Introduction to the Resume - Types of Resumes - The Chronological Resume - The Functional Resume - The Combination Resume - Curricula Vitae - Preparing to Write Your Resume - Common Resume Errors – Presentation - Professional Objective and Education Section – Experience / Fresher - Skills Section - Honors and Awards - Activities and Interests - Polishing Your Resume - Cover Letters.

UNIT - IV   BUSINESS ETIQUETTE AND ETHICS   **[06]**

Grooming Etiquette – Telephone & Email Etiquette – Dining Etiquette - do's and don't's in formal setting – How to Impress.

Ethics – Importance of ethics and Value – choice and dilemmas faced – Discussion form news headlines.

UNIT - V   DOMAIN PROFICIENCY   **[06]**

Competitive exam training: Design of Transmission Systems - Computer Aided Manufacturing - Refrigeration and Air Conditioning - Quality, Reliability and Maintenance Engineering.

Total = 30 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Enhance the team spirit and working in a team effectively.*
- *C02: Organize better & perform well in HR interview.*
- *C03: Tailor their own resume accordingly.*
- *C04: Understand business etiquette job needs & work globally.*
- *C05: Enhance the technical skills in competitive exams.*

Reference Books :

1. Aggarwal, R.S. "A Modern Approach to Verbal and Non-verbal Reasoning", Revised Edition 2008, Reprint 2009, S.Chand & Co Ltd., New Delhi.
2. Abhijit Guha, "Quantitative Aptitude", TMH, 3 edition.
3. Objective Instant Arithmetic by M.B. Lal & Goswami Upkar Publications.
4. Word Power Made Easy by Norman Lewis W.R. GOYAL Publications.

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<u>**SEMESTER – VII**</u>

16HS751	**PROFESSIONAL ETHICS**	L	T	P	C
	(Common to All Branches)	3	0	0	3

Prerequisite: No Prerequisites are needed for enrolling into the course.

Objective:

- *To enable the student to understand the ethical principles and practices to resolve the ethical conflict Situations that arise in their professional lives.*

UNIT - I   ENGINEERING ETHICS   **[09]**

Senses of 'Engineering Ethics' - Variety of Moral Issued - Types of Inquiry - Moral dilemmas - Moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and Controversy - Models of Professional roles – Professional Ideals and Virtues- Uses of Ethical Theories.

UNIT - II   ENGINEERING AS SOCIAL EXPERIMENTATION   **[09]**

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

UNIT - III   ENGINEER'S RESPONSIBILITY FOR SAFETY   **[09]**

Safety and Risk - Assessment of Safety and Risk - Risk Benefit Analysis - Reducing Risk – **Liability** - The Chernobyl and Bhopal Case Studies.

UNIT - IV   RESPONSIBILITIES AND RIGHTS   **[09]**

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

UNIT - V   GLOBAL ISSUES   **[09]**

Multinational Corporations - Environmental Ethics - Computer Ethics - Weapons Development - Engineers as Managers-Consulting Engineers-Engineers as Expert Witnesses and Advisors –Honest- Moral Leadership-Sample Code of Conduct.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

   C01:   Understand basic perception of ethics, moral and values.
   C02:   Aware the current industrial standards.
   C03:   Identify and assess the risk and safety benefit in industry.
   C04:   Aware of professional rights and responsibility of an engineers.
   C05:   Acquire knowledge in global issues and able to apply in ethical principles in professional life.

Text Books :

1.   Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, 3rd edition, New York, 2014.
2.   Dr.K.R.govindan and S.Senthilkumar, "Professional Ethics", Anuradha Agencies, Revised Edition, Chennai, 224.

Reference Books :

1.   Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India,2nd edition, New Delhi, 2012.
2.   Charles D. Fleddermann, "Engineering Ethics", Pearson Education / Prentice Hall, New Jersey,4th edition, 2009.
3.   Charles E Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics - Concepts and Cases", Thompson Learning,4th edition, 2011.
4.   John R Boatright, "Ethics and the Conduct of Business", Pearson Education,5th edition, New Delhi, 2009.

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<u>**SEMESTER - VII**</u>

		L	T	P	C
16ME712	**FINITE ELEMENT ANALYSIS**	3	0	0	3

Prerequisites *: Basic Mechanics, Strength of Materials.*

Objective *:*

- *To learn about the fundamentals of Finite Element models and its procedure.*

UNIT – I   **INTRODUCTION**   **[09]**

Historical background - relevance of FEA to design problems, application to the continuum - discretisation - matrix approach, matrix algebra - Gaussian elimination - governing equations for continuum - classical techniques in FEM - weighted residual method - Ritz method, Galerkin method.

UNIT - II   **ONE DIMENSIONAL PROBLEMS**   **[09]**

Finite element modeling - coordinates and shape functions - potential energy approach - element matrices and vectors - assembly for global equations - boundary conditions - higher order elements - shapes functions - applications to axial loadings of rods - extension to plane trusses - bending of beams - finite element formulation of stiffness matrix and load vectors - assembly to global equations - boundary conditions - solutions and post processing - example problems.

UNIT - III   **TWO DIMENSIONAL PROBLEMS - SCALAR VARIABLE PROBLEMS**   **[09]**

Finite element modeling - CST element - element equations, load vectors and boundary conditions - assembly - application to heat transfer - examples.

UNIT - IV   **TWO DIMENSIONAL PROBLEMS - VECTOR VARIABLE PROBLEMS**   **[09]**

Vector variable problems - elasticity equations - plane stress, plane strain and axisymmetric problems -formulation - element matrices - assembly - boundary conditions and solutions - examples.

UNIT - V   **ISOPARAMETRIC ELEMENTS FOR TWO DIMENSIONAL PROBLEMS**   **[09]**

Natural coordinates, iso parametric elements, four node quadrilateral element - shape functions - element stiffness matrix and force vector - numerical integration - stiffness integration - displacement and stress calculations - examples.

         Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

     C01: Acquire knowledge about FEA design procedure and Types of classical techniques in FEM.
     C02: Analyze the stresses, strains and displacements of one dimensional elements (bars, trusses and beams).
     C03: Making finite element modeling of constant triangular elements and to determine the stresses, strains and displacements of CST element.
     C04: Recap finite element modeling of two dimensional elements and to formulate the stresses, strains and displacements of two dimensional elements.
     C05: Interpret the finite element modeling of isoparametric elements and to assess the stresses, strains and is placements of isoparametric elements.

Text Books :

1. Chennakesava. R. Alavala., "Finite Element Methods-Basic Concepts and Applications", PHI Learning (P) Limited, New Delhi, 2014.
2. David V Hutton "Fundamentals of Finite Element Analysis". McGraw-Hill Int. Ed, 2004.

References :

1. Klaus-Jurgen Bathe, "Finite Element Procedures", PHI Learning (P) Limited, New Delhi, 2010.
2. Chandrupatla T.R., and Belegundu A.D., "Introduction to Finite Elements in Engineering", Pearson Education 2002, 3rd Edition.
3. Logan D.L., "A First course in the Finite Element Method", Third Edition, Thomson Learning,2002.
4. Robert D.Cook., David.S, Malkucs Michael E Plesha, "Concepts and Applications of Finite Element Analysis" 4 Ed. Wiley, 2003.
5. http://nptel.ac.in.

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SEMESTER – VII

16ME713	MECHATRONICS	L	T	P	C
		3	0	0	3

Prerequisite : *Electronics and Microprocessor.*

Objective :

- *To understand the interdisciplinary application of electronics, electrical, mechanical and computer systems for the control of mechanical systems.*

UNIT - I   MECHATRONICS , SENSORS AND TRANSDUCERS   [09]

Introduction to mechatronics systems - measurement systems - control systems - microprocessor based controllers. Sensors , transducers - performance terminology - sensors for displacement, position , proximity, velocity, force, fluid pressure, liquid flow, liquid level, temperature , light sensor-selection of sensor.

UNIT - II   ACTUATION SYSTEMS   [09]

Pneumatic hydraulic systems - directional control valves - rotary actuators. Mechanical actuation systems - cams - gear train - ratchet and pawl - belt and chain drives - bearing electrical actuation systems -mechanical switches - solid state switches - solenoids - construction and working principle of AC and DC motors - speed control of AC and DC drives, stepper motors - switching circuitries for stepper motor - AC and DC servo motors.

UNIT - III   SYSTEM MODELS AND CONTROLLERS   [09]

Building blocks of mechanical, electrical, fluid and thermal systems, rotational-translational systems, electromechanical systems - hydraulic-mechanical systems. Continuous and discrete process controllers -control mode - two-step mode - proportional mode - derivative mode-integral mode - PID controllers-digital controllers - velocity control - adaptive control - digital logic control.

UNIT - IV   PROGRAMMABLE LOGIC CONTROLLERS   [09]

Basic structure - input/output processing-programming - mnemonics - timers, internal relays , counters - shift registers - master and jump controls - data handling - analog input/output - selection of a PLC.

UNIT - V   DESIGN OF MECHATRONICS SYSTEMS   [09]

Stages in designing mechatronics systems - traditional , mechatronics systems - traditional , mechatronic design - possible design solutions. Case studies of mechatronics systems - pick and place robot - autonomous mobile robot - wireless surveillance balloon - engine management systems.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01: Remember about mechatronic sensors and transducers.*
- *C02: Understand the concepts of Actuation Systems.*
- *C03: Apply the system models & controllers.*
- *C04: Create the programming in PLC.*
- *C05: Analyze the Design of mechatronic systems.*

Text Books :
1. Bolton.W, "Mechatronics",pearson education, second Edition, fifth Indian print,2013.
2. Rajput.R.K. "A text book of mechatronics", S. Chand and co, 2010.

References :
1. Nitaigor Premchand Mahadik, "Mechatronics", Tata McGraw-hill publishing company Ltd, 2007.
2. David G. Alciatore Michael B. Histand, "Introduction to mechatronics and measurement system", TMH, 2007.
3. Michael.B.histand and David G. Alciatore, "Introduction to mechatronics systems", MHI, 2011.
4. Dan necsulesu, "Mechatronics", Pearson education Asia, 2002.
5. http://nptel.ac.in

SEMESTER - VII

		L	T	P	C
16ME714	**ENGINEERING METROLOGY AND MEASUREMENTS**	3	0	0	3

Prerequisites : *Engineering physics, Fluid Mechanics and Machinery.*

Objective   :

- *To learn about the basic principles of measurements and measuring equipments, principles of operation, applications and various methods for measuring mechanical parameters.*

UNIT - I   CONCEPTS OF MEASUREMENTS   [09]

General concepts - generalized measurement system - units and standards – measuring instruments- sensitivity, stability, range, accuracy and precision - static and dynamic response -repeatability - systematic and random errors - correction, calibration - calibration of instruments- vernier, micrometer, vernier height gauge - quality standards - introduction to dimensional and geometric tolerancing - interchangeability.

UNIT - II   LINEAR AND ANGULAR MEASUREMENTS   [09]

Abbe's principle, linear measuring instruments - vernier, micrometer, slip gauges and classification, tool makers microscope - interferometry, optical flats - limit gauges, Taylor's principle of gauge design. Comparators- mechanical, pneumatic and electrical comparators -applications. Angular measurements- sine bar, sine center, bevels protractor and angle decker.

UNIT - III   FORM MEASUREMENTS   [09]

Measurement of screw threads - thread gauges, floating carriage micrometer - measurement of gear tooth thickness - constant chord and base tangent method - Gleason gear testing machine - radius measurements - surface roughness - equipment and parameters - straightness -flatness and roundness measurements.

UNIT – IV   ADVANCES IN METROLOGY   [09]

Precision instruments based on laser - principles - laser interferometer - white light – photo grametry - applications in measurements - coordinate measuring machine (CMM) - need, construction, types, applications - computer aided inspection.

UNIT-V   MEASUREMENT OF MECHANICAL PARAMETERS   [09]

 Force - torque - power - mechanical, pneumatic, hydraulic and electrical type - pressure - flow -venturi, orifice, rotameter, pitot tube - temperature - bimetallic strip, pyrometer, thermocouple and PT100.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

    C01: *Understand the basic concept of measurements and standards.*
    C02: *Apply linear and angular measurements.*
    C03: *Analze the various form measurement techniques.*
    C04: *Explore advances in metrology using laser and CMM.*
    C05: *Apply various measurements of mechanical parameters.*

Text Books :

1.   Anand K Bewoor and Vinay A Kulkarni, "Metrology and Measurement", Tata McGraw-Hill, 2009.
2.   Jain R.K., "Engineering Metrology", Khanna Publishers, 2005.

Reference Books :

1.   Gupta S.C, "Engineering Metrology", Dhanpat rai Publications, 2005.
2.   Jayal A.K, "Instrumentation and Mechanical Measurements", Galgotia Publications 2000.
3.   Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2006.
4.   Khurmi R.S., "Metrology and Measurements", Schand Publications, 2009.

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<u>**SEMESTER -VII**</u>

		L	T	P	C
16ME721	**MECHATRONICS LABORATORY**	0	0	3	2

Prerequisite : *Electronics and Microprocessor Laboratory.*

Objective :

- *To make use of electrical, electronics, mechanical and computer systems for the control of mechanical systems.*

LIST OF EXPERIMENTS

1. Design and testing of fluid power circuit to control (i) velocity, (ii) direction and (iii) force of single and double acting actuators.
2. Design of pneumatic circuit for a Sequential operation of two cylinders using basic trainer kit.
3. Design of circuits with logic sequence using electro pneumatic trainer kit.
4. Design of pneumatic circuit for a continuous operation using PLC trainer kit.
5. Study the characteristics of servo controller interfacing for open loop and closed loop.
6. Study on the characteristics of speed control when PID controller interfaced with AC and DC motor.
7. Design of a hydraulic circuit for continuous operation using simulation software.
8. Design of a pneumatic circuit for sequential operation of multiple cylinders using simulation software.
9. Compare the analog process variables such as pressure, flow and temperature with digital outputs obtained through data logging with computer.
10. Design of circuit for Recovery of child from Bore wells.

Total = 45 Periods

LIST OF EQUIPMENT

1	Basic pneumatic trainer kit	-1 No
2	Electro pneumatic trainer kit	-1 No
3	Electro pneumatic trainer kit with PLC control	-1 No
4	Hydraulic Trainer kit	-1 No
5	PID Controller Interfacing	-1 No
6	Speed Control of AC and DC Drives	-1 No
7	Hydraulic/pneumatic systems simulation software	-10 users

Course Outcomes: On completion of this course, the students will be able to

   C01: *Understand the Design and testing of fluid power circuit to control velocity, direction and force of single and double acting actuators.*

   C02: *Create the Design of pneumatic circuit for a sequential operation of two cylinders using basic, electro pneumatic trainer kit & using software.*

   C03: *Apply the Design of circuits with logic sequence using electro pneumatic trainer kit.*

   C04: *Evaluate the Design of pneumatic circuit for a continuous operation of two cylinders using PLC trainer kit.*

   C05: *Recall the characteristics of servo controller interfacing for open loop and closed loop & speed control when PID controller interfaced with AC and DC motor.*

   C06: *Comparing the analog process variables such as pressure, flow, and temperature with digital outputs obtained through data logging with computer.*

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<u>**SEMESTER - VII**</u>

		L	T	P	C
16ME722	**COMPUTER AIDED SIMULATION AND ANALYSIS LABORATORY**	0	0	3	2

Prerequisite: *Finite Element Analysis.*

Objective   :

- *To acquire knowledge on the simulation and analysis of the stress, vibration and Heat transfer on the mechanical components using suitable software packages.*

LIST OF EXPERIMENTS

1. Stress analysis of a Bar element.
2. Stress analysis of a plate with a circular hole.
3. Stress analysis of a rectangular L Bracket.
4. Stress analysis of beams (Cantilever, Simply supported, Fixed).
5. Modal analysis of beams (Cantilever, Simply supported, Fixed).
6. Harmonic analysis of a 2D component.
7. Thermal stress analysis of a 2D component.
8. Conductive, convective, insulated heat transfer analysis of a 2D component.
9. Simulation of Spring Mass Damper System Control.
10. Simulation of heat exchanger process.

Total = 45 Periods

LIST OF EQUIPMENT

1. **Computer system**   **- 30 Nos.**
   17" VGA Color Monitor,
   Pentium IV Processor,
   40 GB HDD, 512 MB RAM
2. **Color desk Jet Printer**   **- 01 Nos.**
3. **Software**

   Simulation and analysis software like ANSYS, SOLIDWORKS, C, MATLAB, NXNASTRAN, ADAMS, AUTOMATION

   STUDIO   - **30 licenses.**

Course Outcomes: On completion of this course, the students will be able to
   C01: Predict the stress, strain and displacement for the simple specimen in ANSYS software.
   C02: Analyze the structure of different types of Beams with the help of ANSYS software.
   C03: Understand the Simple Harmonic and Modal analysis in various beams by using ANSYS software.
   C04: Demonstrate the thermal analysis problems by using ANSYS software.
   C05: Understand the Simulation and analysis of vibration problems by using MAT Lab software.
   C06:   Apply the concept of air conditioning system for various applications using MAT Lab software.

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<u>**SEMESTER – VII**</u>

	L	T	P	C
	0	0	3	2

16ME723   **MAINTENANCE LABORATORY**

Prerequisites : *Manufacturing Technology Laboratory, Thermal Engineering Laboratory.*

Objective   :

• *To understand the procedure involved in maintenance of mechanical components.*

LIST OF EXPERIMENTS

1. Preparation of preventive maintenance schedule for institution machine shop.
2. Inspection, removal, cleaning, lubrication and refitting of bearings.
3. Maintenance, repair and replacement of couplings and alignment of shafts.
4. Belt drives - mounting of belts and checking of slip.
5. Chain drives - tightening and replacement of chains.
6. Dismantling and assembling of pumps.
7. Dismantling and assembling of an internal combustion engine.
8. Dismantling and assembling of an air conditioning system.
9. Test for Level of installation of machine tool in longitudinal and transverse direction.
10. Test for flatness of machine tool and true running of the main spindle.

Total = 45 Periods

LIST OF EQUIPMENT

1.	Bearing	1 No.
2.	Coupling	1 No.
3.	Belt and Chain drives	1 No.
4.	Pump	1 No.
5.	IC Engine	1 No.
6.	Air conditioning system	1 No.

Course Outcomes: On completion of this course, the students will be able to

C01: *Identify and select appropriate tools to preparation of preventive maintenance schedule for machine shop.*

C02: *Understand complete methodology of evaluation and maintenance of machine parts such as bearings.*

C03: *Develop skills in dismantling and assembling of an I.C engines using instruments and special tools.*

C04: *Acquire knowledge and skills in the fundamental disciplines of an evaluation and maintenance concepts for coupling assembly.*

C05: *Explain machine tool alignment tests.*

C06: *Enhance the Practical Guide of troubleshooting, installation and maintenance of various drives.*

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SEMESTER – VII

		L	T	P	C
16ME724	**ENGINEERING METROLOGY AND MEASUREMENTS LABORATORY**	0	0	3	2

Prerequisites: *Manufacturing Technology Laboratory, Strength of Materials Laboratory.*

Objective   :

- *To facilitate the students to use measuring instruments in various mechanical quantities.*

LIST OF EXPERIMENTS

1. Checking dimensions of parts using vernier, micrometer, height and depth gauge.
2. Measurement of gear tooth dimensions.
3. Measurement of angle using sine bar / sine center.
4. Measurement of gear tooth profile using profile projector.
5. Measurement of straightness and flatness using autocollimator.
6. Component inspection by electrical comparator and Go - No Go gauges.
7. Calibration of micrometer and vernier caliper using slip gauges.
8. Measurement of temperature using thermocouple
9. Tool geometry measurement using tool makers microscope.
10. Measurement of displacement, force and torque.

Total = 45 Periods

LIST OF EQUIPMENT

1.	Micrometer	-	5 Nos.
2.	Vernier Caliper	-	5 Nos.
3.	Vernier Height Gauge	-	2 Nos.
4.	Vernier depth Gauge	-	2 Nos.
5.	Slip Gauge Set	-	1 No.
6.	Gear Tooth Vernier	-	1 No.
7.	Sine Bar	-	1 No.
8.	Sine Center	-	1 No.
9.	Bevel Protractor	-	1 No.
10.	Floating Carriage Micrometer	-	1 No.
11.	Profile Projector	-	1 No.
12.	Tool Makers Microscope	-	1 No.
13.	Mechanical / Electrical Comparator	-	1 No.
14.	Autocollimator	-	1 No.
15.	Temperature Measuring Setup	-	1 No.
16.	Displacement Measuring Setup	-	1 No.
17.	Force Measuring Setup	-	1 No.
18.	Torque Measuring Setup	-	1 No.

Course Outcomes: On completion of this course, the students will be able to

> C01: *Demonstrate calibration of vernier caliper, micrometer, thermocouple .*
> C02: *Justify the dimensions of part using slip gauges, Angle using sine bar / sine center / tool makers microscope.*
> C03: *Evaluate the gear tooth profile used profile projector and tool makers microscope.*
> C04: *Predict the Gear Tooth Dimensions, straightness, flatness and thread parameters.*
> C05: *Understand the Setting up of comparators for inspection (Mechanical / Pneumatic / Electrical).*
> C06: *Investigate the Measuring techniques of Force, Torque and Measuring of Vibration / Shock.*

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SEMESTER - VIII

16HS002	TOTAL QUALITY MANAGEMENT	L	T	P	C
	(Common to AU, CE, CS, EE, IT & ME)	3	0	0	3

Prerequisite: *No Prerequisites are needed for enrolling into the course.*

Objective :

- *To understand the Total Quality Management concept, tools available to achieve quality in every process of operations.*

UNIT - I   INTRODUCTION   [09]

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM implementation steps – Quality council-Importance of leadership and motivation in TQM - Contributions of Deming, Juran and Crosby – Barriers to TQM.

UNIT - II   TQM PRINCIPLES   [09]

Quality statements - Customer perception of quality – Customer complaints, Customer retention. Employee involvement , Empowerment, Team and Teamwork, Recognition and Reward - Continuous process improvement – Juran trilogy, PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT - III   STATISTICAL PROCESS CONTROL   [09]

The seven traditional tools of quality – Measurement of central tendency and dispersion, population and sample, normal curve, control chart (X,R,p) for variable and attributes, process capability - Seven new management tools – Six-sigma Concepts.

UNIT - IV   TQM TOOLS   [09]

Bench marking – reason , process – Quality circles concepts - FMEA – stages, types– Quality Function Deployment (QFD) – Taguchi quality loss function –TPM – concepts, improvement needs –Performance measures-criteria – Quality Cost.

UNIT - V   QUALITY SYSTEMS   [09]

Need for ISO 9000 – ISO 9001-2008, ISO 14000 Quality System – elements, implementation, Documentation. Quality auditing – concepts, requirements and benefits, non conformance report – Case studies of TQM implementation in manufacturing and service sectors.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

C01:   *Explore TQM framework to improve the quality of the products and services.*
C02:   *Apply TQM principles for continuous process improvement.*
C03:   *Interpret statistical tools to control and improve the quality of the products and services.*
C04:   *Implement the tools and techniques to improve the quality concept.*
C05:   *Understand the quality system in manufacturing and service sectors.*

Text Book :

1.   Dale H.Besterfiled, et at., "Total Quality Management", Pearson Education Asia,Third Edition, Indian Reprint (2006).

Reference Books :

1.   Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases",Prentice Hall (India) Pvt. Ltd., 2006.
2.   Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India)Pvt. Ltd.,2006.
3.   James R. Evans and William M. Lindsay, "The Management and Control of Quality",6th Edition, South-Western (Thomson Learning), 2005.
4.   Subburaj R, Total Quality Management, Tata McGraw Hill, New Delhi 2005.

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SEMESTER - VIII

	L	T	P	C
16ME821 **PROJECT PHASE-II**	0	0	12	6

Prerequisite : Industry Internship and Project Phase-I.

Objective   :

- *To prepare students to gain confidence in solving real time engineering problems.*

GUIDELINES:

1. The objective of the project work is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the branch of study.

2. Every project work shall have a guide who is the member of the faculty of the institution.

3. Twelve periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the project.

4. The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design and manufacture of a device, a research investigation, a computer or management project or a design problem.

5. The progress of the project is evaluated based on a minimum of three reviews.

6. The review committee may be constituted by the head of the department.

7. The students shall be encouraged to apply for funded projects, patents, publish in journals, conferences and symposiums.

8. Each student shall finally produce a comprehensive report covering background information, literature survey, problem statement, project work details and conclusion.

9. This final report shall be type written form as specified in the guidelines.

10. The project report should be evaluated jointly by external and internal examiners.

Total = 180 Periods

Course Outcomes: On completion of this course, the students will be able to

    C01: Identify real time problems.
    C02: Acquire knowledge on the industrial oriented projects.
    C03: Collect the data from the literature surveys and find out the solutions.
    C04: Select the topic based on the critical problems identified.
    C05: Summarize the problems identified and can be compared with the legal requirements.
    C06: Apply the solutions for the problems identified.

SEMESTER – VI

16MA686	PROBABILITY AND STATISTICS	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite :   *No Prerequisites are needed for enrolling into the course.*

Objectives   :

- *To understand basic concepts in random variables.*
- *To understand the techniques of correlation and regression analysis.*
- *To test the data by using testing of hypothesis.*
- *To acquire knowledge in non-parametric tests.*
- *To understand the concept of design of experiments.*

UNIT - I   ONE DIMENSIONAL RANDOM VARIABLE   [09]

Random variables - probability function - moments - moment generating functions and their properties- binomial, poisson, exponential and normal distributions (based on problems only).

UNIT - II   CORRELATION AND REGRESSION ANALYSIS   [09]

Karl-Pearson's coefficient of correlation - spearman's rank correlation - concurrent correlation - regression lines - angle between two regression lines.

UNIT - III   TESTING OF HYPOTHESIS   [09]

Sampling distributions - type I and type II errors - tests based on small and large samples, $\chi 2$ - distributions for independence of attributes and F distributions for testing of variance.

UNIT - IV   NON - PARAMETRIC TESTS   [09]

Sign test: one sample and paired tests - rank sum test: Mann-Whitney U test - one sample run test – Kruskal Wallis H test.

UNIT - V   DESIGN OF EXPERIMENTS   [09]

Analysis of variance - one-way and two-way classifications - completely randomized design - randomized block design - Latin square design.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

- C01:   *Understand the concept of one dimensional random variable and distributions.*
- C02:   *Apply the concepts of correlation and regression analysis.*
- C03:   *Determine the inference of the samples by using various methods in testing of hypothesis.*
- C04:   *Evaluate the samples by non-parametric tests and finding the inferences.*
- C05:   *Interpret variances by design of experiments to obtain inferences.*

Text Book:

1. Gupta S.P, "Statistical Methods", Sultan Chand & Sons, New Delhi, thirty first edition, 2002.

References:

1. Jay L. Devore, "Probability and Statistics for Engineers", CENGAGE Learning, Indian Edition, Singapore, 2008.
2. Montgomery D. C and Runger G. C, "Applied Statistics and Probability for Engineers", Third Edition, John Wiley and Sons, 2007.
3. Gupta S. C and Kapoor V. K, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi, 2001.

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<u>**SEMESTER - VI**</u>

16ME662	**DESIGN OF JIGS, FIXTURES AND PRESS TOOLS**	L	T	P	C
	(Use of PSG Design Data Book permitted)				
	ELECTIVE	3	0	0	3

Prerequisites : Design of Machine Elements ,Manufacturing Technology-I.

Objective   :

• *To learn about the functions and design principles of Jigs, fixtures and press tools.*

UNIT - I   TOOL ENGINEERING   [09]

Introduction - classifications - tool design objectives - tool design in manufacturing - challenges and requirements - standards in tool design - tool drawings - surface finish - tooling materials - ferrous and non ferrous tooling materials - carbides, ceramics and diamond - non metallic tool materials.

UNIT - II   LOCATING AND CLAMPING PRINCIPLES   [09]

Objectives - function - advantages of jigs, fixtures - basic elements - principles of location - degrees of freedom - degrees of mobility - locating methods, devices - redundant location - principles of clamping - mechanical actuation – pneumatic, hydraulic actuation standard parts - drill bushes, jig buttons - tolerances, materials used.

UNIT - III   JIGS AND FIXTURES   [09]

Design, development of jigs, 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 - IV   PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES   [09]

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, preparation of four standard views of simple blanking, piercing, compound, progressive dies - design of molds for plastic injection.

UNIT – V   BENDING FORMING AND DRAWING DIES   [09]

Difference between bending, forming, drawing - blank development for above operations - types of bending dies - press capacity - spring back - knockouts - direct, indirect - pressure pads - ejectors - variables affecting metal flow in drawing operations - draw die inserts - draw beads - ironing - design, development of bending, forming, drawing reverse re-drawing, combination dies - blank development for axi-symmetric, rectangular and elliptic parts - single, double action dies - forging.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

　　C01: *Understand tool engineering concepts, purpose and characteristics with their properties.*
　　C02: *Identify various locating, clamping devices, principles used in jigs and fixtures.*
　　C03: *Discuss purposes and principles of jigs &fixtures.*
　　C04: *Understand press working terminologies & elements of cutting dies.*
　　C05: *Analyze bending, forming, drawing dies on various components.*

Text Books :

1.　Joshi, P.H, "Jigs and Fixtures", Third Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2004.

2.　Donaldson, Lecain and Goold, "Tool Design", III rd Edition, Tata McGraw Hill, 2000.

Reference Books :

1.　Hoffman, "Jigs and Fixture Design" - Thomson Delmar Learning, Singapore, 2004.

2.　Venkataraman K, "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005.

3.　ASTME, "Fundamentals of Tool Design", Prentice Hall of India, 2010.

4.　Chapman W.A.J Workshop technology, Edward Arnold ,London,U.K,1975.

SEMESTER – VI

16ME663	INTRODUCTION TO AIRCRAFT INDUSTRY AND AIRCRAFT SYSTEMS	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite : Basic Mechanics .

Objectives   :

- *To gain the exposure to the aerospace industry.*
- *To understand the basics of aircraft systems and aircraft structures.*
- *To study about the industrial practices on design of aircraft structures.*
- *To understand the applicability of design aspects of aircraft.*

UNIT - I   OVERVIEW ON AIRCRAFT INDUSTRY   [09]

History of flight, types of aerospace industry – Keyplayers in aerospace industry – Aerospace manufacturing, Industry supply chain , Prime contractors – Tier 1 suppliers, key challenges in industry supply chain, OEM supply chain strategies, Advances in Engineering/CAD/CAM/CAE tools and Materials technology – Global and Indian aircraft scenario.

UNIT - II   INTRODUCTION TO AIRCRAFTS   [09]

Basic components of aircraft, Structural members, aircraft axis system & motions –Control surfaces and High lift devices – Types of aircrafts- lighter/heavier than air, Aircrafts conventional design configurations based on power plant location, wing vertical location, intake location, tail unit arrangements, landing gear arrangements – Unconventional configurations – Biplane, Variable sweep, Canard layout, Twin boom layouts, Span loaders, blended body wing layout – Advantages and limitations of these configurations.

UNIT - III   INTRODUCTION TO AIRCRAFT SYSTEMS   [09]

Types of aircraft systems. Mechanical systems – Enviromental control system(ECS), Hydraulic and Pneumatic systems, Fuel system, landing gear system, Engine control system, Ice and rain protection systems, steering and brake systems – Electrical systems – Avionics, Flight controls, Autopilot and Flight management system, Radar system.

UNIT - IV   BASIC PRINCIPLES OF FLIGHT   [09]

Significance of speed and sound, air speed and ground speed, properties of atmosphere, forces on the airplane – airflow over wing section, Pressure distribution over wing section - Generation of Lift, Drag and pitching moments- Factors affecting Lift and Drag, Centre of pressure and its effects.

UNIT - V   BASICS OF FLIGHT MECHANICS   [09]

Mach waves, Mach Angles, Sonic and Supersonic Flight and its effects, Stability and control – Lateral, Longitudinal and Directional Stability and Controls of aircraft. Effects of Flaps and Slats on Lift Coefficients, control tabs, Stalling, Landing, gliding, turning, speed of sound. Aircraft performance- power curves, maximum and minimum speeds of horizontal flight, effects of Altitude on Power curves – Forces acting on aeroplane during turn, Loads during the turn.

Total =45 Periods

Course Outcomes: On completion of this course, the students will be able to

    C01: Learn about overview on aircraft industry.
    C02: Gain the knowledge on basic components of aircrafts.
    C03: Study the classification of aircraft systems.
    C04: Gain the knowledge on the basic principles of flight.
    C05: Understand the basics of flight mechanics.

Text Books :

1.   Stephen Corda, "Introduction to Aerospace Engineering", Wiley , 2015.

2.   Wayne Durham, Kenneth A.Bordignon and Roger Beck, "Aircraft control allocation" Wiley, 2015.

Reference Book :

1.   Ian Moir and Allen seabridge, "Aircraft systems" third edition, Wiley.

SEMESTER - VI

16ME664   **POWER PLANT ENGINEERING**   L   T   P   C
                            ELECTIVE   3   0   0   3

Prerequisites : *Engineering Physics, Engineering Thermodynamics.*

Objectives   :
- *To understand various components, operations, applications and site selection criteria of   different types of power plants.*
- *To understand power plant economics and comparison of economics of various power plants.*

UNIT - I   HYDEL POWER PLANT AND STEAM BOILERS   [09]

Layout of Hydel power plants – Types – Standalone – Pumped Storage. Steam Boilers and cycles – High pressure and supercritical boilers – Fluidized bed boilers – Analysis of power plant cycles - Combined power cycles – comparison and selection.

UNIT - II   STEAM POWER PLANT   [09]

Layout and types of Steam Power Plants - Fuel and Ash handling systems – combustion equipment for burning coal – Mechanical stokers – Pulverizers – Electrostatic precipitator – Draught – different types, Surface condenser types, Cooling towers, Pollution Controls.

UNIT - III   NUCLEAR POWER PLANTS   [09]

Nuclear energy - Fission, Fusion reaction - Layout of nuclear power plants - Types of reactors, pressurized water reactor - Boiling water reactor - Gas cooled reactor - Fast breeder reactor - Waste disposal and safety.

UNIT - IV   DIESEL AND GAS TURBINE POWER PLANTS   [09]

Layout and types of Diesel power plants and components, selection of engine type, applications. Gas Turbine power plant – Layout - Fuels, gas turbine material, types of combustion chambers - reheating, regeneration and inter - cooling.

UNIT - V   POWER PLANT ECONOMICS   [09]

Economics of power plant – Actual load curves-cost of electric energy-fixed and operating costs-energy rates – Types of Tariffs – Economics of load sharing – variable load operation - comparison of economics of various power plants.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
   - *C01:   Select the suitability of site for a power plant.*
   - *C02:   Calculate performance of thermal power plant and Propose ash handling, coal handling method in this plant.*
   - *C03:   Explain working principle of different types of nuclear power plant.*
   - *C04:   Calculate load factor, capacity factor, average load and peak load on a power plant.*
   - *C05:   Analyze the Cost analysis and comparison of economics of various plants.*

Text Books :

1.   Arora S.C. and Domkundwar.S, 'A Course in Power Plant Engineering', Dhanpatrai, 2001.

2.   Nag P.K., 'Power Plant Engineering', Tata-McGraw Hill, 1998.

Reference Books :
1.   Frank D.Graham,'Power Plant Engineers Guide', D.B. Taraporevala Sons &Co., New Delhi, 1993.
2.   T.Morse Frederick,'Power Plant Engineering', Prentice Hall of India, 1998.
3.   R.K.Rajput,'Power Plant Engineering', Laxmi Publications,1995.
4.   G.D.Rai, "Introduction to Power Plant Technology", Khanna Publishers, 1995.

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<u>**SEMESTER- VI**</u>

16ME665	NUCLEAR ENGINEERING	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite *: Engineering physics.*

Objective *:*

- *To gain some fundamental knowledge about nuclear physics, nuclear reactor, nuclear fuels, reactors and safe disposal of nuclear wastes.*

UNIT - I   NUCLEAR PHYSICS   **[09]**

Nuclear model of an atom-equivalence of mass and energy – binding - radio activity - half life - neutron interactions - cross sections.

UNIT - II   NUCLEAR REACTIONS AND REACTION MATERIALS   **[09]**

Mechanism of nuclear fission and fusion - radio activity - chain reactions - critical mass and composition - nuclear fuel cycles and its characteristics - uranium production and purification - zirconium, thorium, beryllium.

UNIT - III   REPROCESSING   **[09]**

Reprocessing: nuclear fuel cycles - spent fuel characteristics - role of solvent extraction in reprocessing -solvent extraction equipment - global status of reprocessing.

UNIT - IV   NUCLEAR REACTOR   **[09]**

Nuclear reactors: principles - classification - types of fast breeding reactors - design and construction of fast breeding reactors - heat transfer techniques in nuclear reactors - reactor shielding - fusion reactors.

UNIT - V   SAFETY AND DISPOSAL   **[09]**

Safety and disposal: Nuclear plant safety - safety systems - changes and consequences of accident - criteria for safety - nuclear waste - types of waste and its disposal - radiation hazards and their prevention.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

C01:   Remember the knowledge about nuclear physics.
C02:   Recognize the nuclear reactions and reaction materials.
C03:   Analyze the reprocessing.
C04:   Categorize the nuclear reactor.
C05:   Organize the disposal of nuclear waste.

Text Books:
1.   John R. Lamarsh and Anthony J. Baratta, "Introduction to Nuclear Engineering", Pearson Edition, 2001.
2.   W. M. Stacey, Nuclear Reactor Physics, John Wiley & Sons, 2007.

References:
1.   J.Kenneth Shutting, Richard E.Faw.,"Fundamentals of Nuclear Science And Engineering".2011.
2.   S.L.Kakani., "Nuclear and Particle Physics"-ANSHAN Publication.2008.
3.   Collier J.G., and Hewitt G.F, "Introduction to Nuclear power", Hemisphere publishing, New York. 2000.
4.   WakilM.M.El., "Power Plant Technology" - McGraw-Hill International, 1984.

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<u>**SEMESTER – VI**</u>

16ME666	**GAS DYNAMICS AND JET PROPULSION**	L	T	P	C
	(Use of standard Gas Table data book permitted)				
	ELECTIVE	3	0	0	3

Prerequisites: *Engineering Thermodynamics, Fluid Mechanics and Machinery, Thermal Engineering ,Heat and Mass Transfer.*

Objectives:

- *To understand the basic difference between incompressible and compressible flow.*
- *To understand the phenomenon of shock waves and its effect on flow.*
- *To gain some basic knowledge about jet propulsion and Rocket propulsion.*

UNIT - I   BASIC CONCEPTS OF COMPRESSIBLE FLOW   [09]

Energy and momentum equations for compressible fluid flows - Various regions of flows - Reference velocities, stagnation state, velocity of sound, critical states - Mach number, Mach waves, Mach cone, Mach angle, Effect of Mach number on compressibility - flow through nozzle and diffuser.

UNIT - II   FLOW THROUGH DUCTS   [09]

Flow through constant area ducts with heat transfer (Rayleigh flow) - Rayleigh line and Rayleigh flow equation - flow through constant area ducts with friction (Fanno flow) - Fanno curves and Fanno equation - variation of flow properties - variation of Mach number with duct length.

UNIT - III   NORMAL AND OBLIQUE SHOCKS   [09]

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal and oblique shocks - Prandtl-Meyer equation – use of tables and charts.

UNIT - IV   JET PROPULSION   [09]

Theory of jet propulsion – thrust equation – thrust power and propulsion efficiency – operation principle, cycle analysis and use of stagnation state performance of ram jet engine, turbojet, turbofan and turbo prop engines.

UNIT - V   SPACE PROPULSION   [09]

Theory of rocket engines – propellants feeding system – ignition and combustion - theory of rocket propulsion – Performance study – applications.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Learn about the basic concept and importance of Gas dynamics.*
- *C02: Understand how the flow takes place in Fanno and Rayleigh line.*
- *C03: Acquire the basic knowledge of the phenomena of normal and oblique shocks.*
- *C04: Identify and analyze the basic principle of jet propulsion, types, comparison with rocket propulsion and its applications.*
- *C05: Estimate the various performance efficiencies of rocket engines.*

Text Books :

1. Yahya.S.M., 'Fundamentals of Compressible flow" , New Age International (P) Ltd., New Delhi, 2010.
2. Anderson,J.D., "Modern Compressible flow", McGraw Hill, 3rd Edition, 2003.

References :

1. Ganesan .V., "Gas Turbines", Tata McGraw-Hill, New Delhi, 1999.
2. P.Hill and C.Peterson, "Mechanics and Thermodynamics of Propulsion", Addison - Weseley Publishing Company, 1992.
3. N.J.Zucrow, "Principles of Jet Propulsion and Gas Turbines", John Wiley, New York, 1970.
4. PR.S.L. Somasundaram, "Gas Dynamics and Jet Propulsion", New Age International Publishers, 1996.
5. http://nptel.ac.in.

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SEMESTER - VI

16ME667	COMPOSITE MATERIALS	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite *: Engineering Materials and Metallurgy.*
Objective *:*

• *To learn about the different types of composite materials, their properties and its applications.*

UNIT - I   INTRODUCTION TO COMPOSITES   [09]

Fundamentals of composites - need for composites - enhancement of properties - classification of composites - matrix - polymer matrix composites (PMC), metal matrix composites (MMC), ceramic matrix composites (CMC) - reinforcement - particle reinforced composites, fibre reinforced composites. application of various types of composites.

UNIT - II   POLYMER MATRIX COMPOSITES   [09]

Polymer matrix resins - thermosetting resins, thermoplastic resins - reinforcement fibres - rovings - woven fibres - non-woven random mats - various types of fibres. PMC processes - hand lay-up processes - spray up processes - compound moulding - reinforcement reaction - injection moulding - resin transfer moulding - pultrusion - filament winding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GRP).

UNIT - III   METAL MATRIX COMPOSITES   [09]

Characteristics of MMC, various types of metal matrix composites alloy Vs MMC, advantages of MMC, limitations of MMC, metal matrix, reinforcement - particles and fibres - effect of reinforcement - volume fraction - rule of mixture - processing of MMC - powder metallurgy process - diffusion bonding - stir casting - squeeze casting.

UNIT - IV   CERAMIC MATRIX COMPOSITES   [09]

Engineering ceramic materials - properties - advantages - limitations - monolithic ceramics - need for CMC - various types of ceramic matrix composites - oxide ceramics - non-oxide cermics - aluminium oxide - silicon nitride - reinforcement - particle and fibres - whiskers. Sintering - hot pressing - cold isostatic pressing (CL ping) - hot isostatic pressing (HI ping).

UNIT - V   ADVANCES IN COMPOSITES   [09]

Carbon / carbon composites - advantage of carbon matrix - limitations of carbon matrix, carbon fibre -chemical vapour deposition of carbon on carbon fibre. Composites for aerospace applications.

                                                                    Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

   C01:   Build the knowledge about theory of composite materials.
   C02:   Develop the skills on polymer matrix composite fibers.
   C03:   Gain the knowledge about metal matrix composite.
   C04:   Build the knowledge on ceramic matrix composite.
   C05:   Gain the knowledge on advances in composites.

Text Books:

1. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Third Edition, Marcel Dekker Inc, 2007.
2. K.Srinivasan, "Composites Materials-Production, Properties, Testing and Applications", Published by N.K. Mehra for Narosa Publishing House Pvt. Ltd, 2009.

Reference Books:

1. Ronald Gibson, "Principles of Composite Material Mechanics", Tata McGraw Hill, 2007.
2. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, 2006.
3. Autar K. Kaw, "Mechanics of Composite Materials" CRC Press, 2006.
4. Robert M. Jones, "Mechanics of Composite Materials" Taylor and Francis, 1999.

16ME761	**HYDRAULICS AND PNEUMATICS**	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite *: Fluid Mechanics and Machinery.*

Objective　　:

● *To learn about the principles of fluid power systems and apply them in motion control, power transmission etc.*

UNIT - I　　　FLUID POWER SYSTEMS AND FUNDAMENTALS　　　　[09]

Fluids - compressible, incompressible - properties -   introduction to fluid power systems - types, advantages, applications - fluid power symbols. Pascal's law - laminar and turbulent flow - Reynolds's number - Darcy's equation - losses in pipes, valves and fittings.

UNIT - II　　　PUMPS AND ACTUATORS　　　　　　　　　[09]

Pumping theory - positive, non positive displacement pumps - fixed, variable displacement pumps - gear pump, vane pump, piston pump - pump performance. Actuators - linear hydraulic actuators - types of hydraulic cylinders - single acting, double acting, special cylinders like tandem, rod less, telescopic, cushioning mechanism. Rotary actuators - fluid motors, gear, vane, piston motors.

UNIT - III　　　DESIGN OF HYDRAULIC CIRCUITS　　　　　　[09]

Types of valves - direction control - 3/2, 4/2 valves, shuttle valve, check valve. Pressure control - pressure reducing valve, sequence valve. Flow control - fixed, adjustable. Controls - manual, solenoid, pilot, relays. Accumulators - types, circuits, sizing. Intensifier - intensifier circuits - meter-in, meter-out circuits.

UNIT - IV　　　PNEUMATIC SYSTEM AND CIRCUITS　　　　　[09]

Properties of air - pneumatic components - compressors, filters, regulators, lubricators and control valves, quick exhaust valves, pneumatic actuators. Fluid power circuit design - speed control circuit, synchronizing circuit, sequential circuit for simple applications using cascade method - pneumo - hydraulic circuit.

UNIT - V　　　ADVANCED FLUID POWER SYSTEMS　　　　　[09]

Servo systems - hydro mechanical servo systems, electro hydraulic servo systems, proportional valves. Fluidics - introduction to fluidic devices, simple circuits, introduction to electro hydraulic pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Troubleshooting in fluid power circuits.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

> *C01:　Understand the fundamentals of fluid power system.*
> *C02:　Describe the types, working performance study of pumps and actuator in fluid power systems.*
> *C03:　Classify different types of hydraulic, pneumatic valves & servo valves.*
> *C04:　Develop and analyze the hydraulic and pneumatic circuits of simple industrial application.*
> *C05:　Categorize the fluidic devices and PLC application in fluid power system.*

Text Books :

1.　Srinivasan R, "Hydraulic and Pneumatic Controls", TMH, 2011.
2.　Anthony Esposito, "Fluid Power with Applications", Pearson Education, 2009.

Reference Books :

1.　Majumdar S.R., "Pneumatic systems - Principles and Maintenance", Tata McGraw Hill, 1996.
2.　Majumdar S.R., "Oil Hydraulics", Tata McGraw-Hill, 2001.
3.　Shanmugasundaram K, "Hydraulic and Pneumatic Controls", Chand & Co, 2006.
4.　Dudley A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.

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SEMESTER - VII

16ME762	VALUE AND RE-ENGINEERING	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite : *Quality ,Reliability and Maintenance Engineering.*

Objectives :
- *To understand the modern evolving techniques in design field.*
- *To learn the Re-Engineering techniques and case studies in industry.*

UNIT - I   INTRODUCTION TO VALUE ENGINEERING   [09]

Introduction - life cycle of a product - definition - objectives and methodology of value engineering - comparison with other cost reduction techniques - unnecessary cost. Quantitative definition of values - alternatives to increase value - types of values - estimation of product quality/performance.

UNIT - II   PHASES AND APPROACHES IN VALUE ENGINEERING   [09]

Functions – definition, types and relationship between different functions in design of a product - functional cost - functional worth - test for poor value - aim of value engineering. Systematic approach - phases of value engineering in job plan - general phase, information phase, function phase creation/speculation phase, evaluation phase, investigation phase, recommendation and implementation phase.

UNIT - III   DECISIONS AND VALUE STREAM MATRIX   [09]

Decision / evaluation matrix: quantitative comparison of alternatives, estimation of weight factors and efficiency. FAST diagramming: critical path of function, how, why and when logic, supporting and all time functions, ground rule for FAST diagram.

UNIT - IV   CONCEPTS AND TECHNIQUES IN RE-ENGINEERING   [09]

Basic concept - digitization techniques - model reconstruction - data processing for rapid prototyping - data formats - data interfacing, part orientation and support generation, support structure design, model slicing and contour data organization, direct and adaptive slicing, tool path generation.

UNIT - V   CASE STUDIES   [09]

Applications case studies - automotive, aerospace and electronic industries.

                                                            Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01:   Understand the knowledge on value Engineering.*
- *C02:   Choose the phases and approaches in value Engineering.*
- *C03:   Implement the decisions and value stream matrix.*
- *C04:   Analyze the concepts and techniques in Re-Engineering.*
- *C05:   Evaluate the case studies.*

Text Books:
1. "Value Engineering analysis and methodology", Del L.Younker, 2003
2. "Rapid prototyping: Principles and applications", second edition, Chua C.K.,   Leong K.F., and Lim C.S., World Scientific Publishers, 2003.

References:
1. Liou W.Liou, Frank W. Liou, "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Peter D. Hilton, Paul F. Jacobs, "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.
3. L.D. Miles, "Techniques of value analysis and value engineering"., 1989.
4. "Value engineering for cost reduction and product improvement", H S Mittal, 1986.

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SEMESTER – VII

16ME763	**DESIGN OF AIRCRAFT STRUCTURES**	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite : Basic Mechanics .

Objective   :

• *To provide an overview of the issues that need to be addressed in the structural design of an airframe.*

UNIT - I   OVERVIEW AND FUNDAMENTALS OF AIRCRAFT DESIGN PROCESS   [09]

Phases of Aircraft design, Aircraft conceptual design process, preliminary design, detailed design- methodologies. Hooke's law, principal stresses, determinate structures, St venants principle, stress transformation, Stress strain relationship.

UNIT - II   INTRODUCTION TO AIRCRAFT STRUCTURES   [09]

Types of structural members of fulselage and wing section ribs, spars, Frames, Stringers, Longeron, splices, Sectional properties of structural members and their loads. Types of structural joints. Aerodynamic loads- inertia load due to engine, Actuator loads, Manuever loads, VN loads, Gust loads, Ground loads, ground conditions.

UNIT - III   AIRCRAFT MATERIALS AND MANUFACTURING PROCESSES   [09]

Material selection criteria, aluminium, titanium, steel, magnesium and copper alloys- Non metallic materials, Composite materials, uses of advanced smart materials, Manufacturing of AC structural members, Manufacturing processes for composite materials, sheet metal fabrication, welding and super plastic forming and diffusion coating.

UNIT - IV   AIR WORTHINESS AND AIRCRAFT CERTIFICATION   [09]

Airworthiness regulations, Regulatory bodies, Type certification, general requirements, requirements related to Aircraft design covers, Performance and flight requirements, Airframe requirements, Landing requirements. Fatigue and failsafe requirements- Emergency provisions, Emergency landing requirements.

UNIT - V   AIRCRAFT STRUCTURAL REPAIR   [09]

Types of structural damage, nonconformance, Rework, allowable damage limit, Repairable damage limit, overview of ADL analysis, types of repair, Repair considerations and best practices.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

　　C01: Develop fundamental concepts of aircraft design processes.
　　C02: Understand the types of structural members used in aircraft structure.
　　C03: Impart the knowledge on materials and manufacturing processes for the aircraft structural members.
　　C04: Know about the worthiness and certifications of aircrafts.
　　C05: Implement the Aircraft structural Repair.

Text Books :

1.　Mickel .C.Y. Niu, "Airframe structural analysis and sizing", 3rd Edition, Adaso Adastra Engineering centre, 1999.

2.　Mickel .C.Y. Niu, "Airframe structural design", 2nd Edition, Adaso Adastra Engineering centre, 2011.

Reference Books :

1.　David J. Peery, "Aircraft Structures", Dover publications, New york, 2013.

2.　Richard Won mises, "Theory of Flight", TMH, 2012.

3.　T.H.G.Megson, "Introduction to Aircraft Structural analysis", 2nd Edition, Butterworth Heinmann, 2014.

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<u>SEMESTER – VII</u>

16ME764	AUTOMOBILE ENGINEERING	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisites : Basic Mechanics, Thermal Engineering.

Objective   :

• *To understand the construction and working principle of various parts of an automobile.*

UNIT - I   VEHICLE STRUCTURE AND ENGINES   [09]

Types of automobiles - vehicle construction - chassis - frame and body. Engine - classification, components, functions and materials - cooling and lubrication systems - turbo charger and super charger.

UNIT - II   ENGINE AUXILIARY SYSTEMS   [09]

Carburetor - basic types and working principle only - electronic fuel injection system - single point and MPFI system - diesel injection - CRDI system - construction, operation and maintenance of lead acid battery - electrical systems - generator, starting motor and drives, lighting and ignition (magneto coil and electronic type), regulators, cut outs.

UNIT - III   TRANSMISSION SYSTEMS   [09]

Clutch - types, construction, linkages - gear boxes - manual, automatic - simple floor mounted shift mechanism - over drives - transfer box - fluid flywheel - torque converters - propeller shaft - slip joint - differential and rear axle - Hotchkiss drive and torque tube drive.

UNIT - IV   STEERING, BRAKES, SUSPENSION SYSTEMS AND SAFETY DEVICES   [09]

Steering geometry - power steering - types of steering gear box - types of front axle - braking systems - types and construction - diagonal braking system. Suspension systems - front, rear, conventional, air suspension - wheels - tyres - wheel alignment parameters - casher, camber, toe, king pin alignment. Anti lock braking system - airbags - stabilizers.

UNIT - V   ALTERNATE FUELS AND POLLUTION CONTROL METHODS   [09]

Natural gas, LPG, bio-diesel, alcohol and hydrogen in automobiles - concepts of electric and hybrid vehicles - fuel cells - engine emission standards - pollution control methods - emission control by 3-way catalytic controller - electronic engine management system.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

C01: *Develop chassis and identify suitable engine for different applications.*
C02: *Understand the functions of engine auxiliary Systems.*
C03: *Select a suitable conventional and automatic transmission system.*
C04: *Formulate steering, braking and suspension systems.*
C05: *Identify the usage of Electrical vehicles / Hybrid vehicles & various pollution control methods.*

Text Books :

1.   Kirpal Singh "Automobile Engineering Vol. 1 & 2", Standard Publishers, New Delhi, 2011.
2.   Sethi H.M, "Automobile Technology", Tata McGraw-Hill-2003.

Reference Books :

1.   Crouse and Anglin, "Automotive Mechanism", 9th Edition. Tata McGraw-Hill, 2003.
2.   Jain,K.K.,and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers,New Delhi, 2002.
3.   Bob Henderson and John Harold Haynes, "Haynes Tech book OBD – II Manual, Haynes Publication, 2006.
4.   Ganesan V., "Internal Combustion Engines", Fourth Edition, Tata Mcgraw-Hill , 2012.

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SEMESTER - VII

16ME765	RENEWABLE SOURCES OF ENERGY	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite : Power Plant Engineering.

Objective   :

- *To educate the significance of renewable energy sources, energy consumption, energy needs and also Environmental aspects.*

UNIT – I   SOLAR ENERGY   [09]

Solar radiation and its measurements, solar energy conversion, solar energy collectors - flat plate collector, concentrating collector, advantages and disadvantages, storage systems, applications, solar thermal power plants.

UNIT – II   WIND ENERGY   [09]

Introduction, classifications, energy conversion principles, advantages and disadvantages. wind energy generators, forces acting on the blades, storage systems, applications, safety systems.

UNIT – III   BIO ENERGY   [09]

Bio mass - conversion techniques, thermal gasification, photosynthesis. bio gas – types of plants, materials, site selection, design consideration, properties, utilization, pyrolysis, thermo chemical process, liquid fuels.

UNIT – IV   GEO THERMAL AND TIDEL ENERGY   [09]

Geo thermal energy - introduction, hydrothermal resources and geo pressured resources, hot dry rock resources, magma resources and prime movers, materials selection, advantages and disadvantages. tidel energy – introduction, ocean thermal electric conversion (OTEC), energy from tides, mini and micro hydel plants.

UNIT – V   ADDITIONAL ALTERNATE ENERGY SOURCES   [09]

Magneto hydro dynamic (MHD) power generation- principles, design and developments, materials. thermo nuclear fusion energy – nuclear fusions, reactions, requirements, types, advantages and disadvantages, fusion hybrids.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

    C01:   Understand the solar energy.
    C02:   Identify the wind energy.
    C03:   Build the knowledge on Bio energy.
    C04:   Categorize the Geo thermal and tidal energy.
    C05:   Assess the alternate energy sources.

Text Books:

1. Chetan Singh Solanki, Renewable Energy Technologies, PHI Learning Private Limited., New Delhi, 2011.
2. G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.

Reference Books:

1. Twidell, J.W. & Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 1986
2. B.H. Khan, "Non Conventional Energy Resources", Tata McGraw Hill Publishing Company Ltd., New Delhi, Second Edition, 2006.
3. G.S. Sawhney, "Non Conventional Energy Resources", PHI Learning Private Limited., New Delhi, 2012.
4. D.S. Chauhan, S.K. Srivastava, "Non Conventional Energy Resources", New Age International (P) Ltd. New Delhi, 2009

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SEMESTER- VII

		L	T	P	C
16ME766	**FUNDAMENTALS OF NANO SCIENCE**				
	ELECTIVE	3	0	0	3

Prerequisite   : Applied Physics.
Objective   :
- *To know the basic knowledge of nano science and technology*

UNIT - I   INTRODUCTION   [09]

Nano science and technology - implications on physics, chemistry, biology and engineering -classifications of nano structured materials - nano particles - quantum dots, wells and wires. Ultra-thin films - multilayered material. Properties: mechanical, electronic, optical, magnetic and motivation for study (qualitative only).

UNIT - II   PREPARATION METHODS   [09]

Bottom-up and top-down approach: mechanical milling, colloidal routes, self assembly, vapour phase deposition, MOCVD, sputtering, evaporation, molecular beam epitaxy, atomic layer epitaxy, MOMBE, Sol-gel technique.

UNIT - III   PATTERNING AND LITHOGRAPHY   [09]

Introduction to optical /UV electron beam and X RAY lithography systems and processes, wet etching, dry (plasma/reactive ion) etching, etch resists - dip pen lithography, nano imprint lithography and soft lithography.

UNIT - IV   PREPARATION ENVIRONMENT AND HAZARDS   [09]

Clean rooms: specifications and design, air and water purity, requirements for particular processes, vibration free environments: services and facilities required. Working practices, sample cleaning, chemical purification, chemical and biological contamination, safety issues, flammable and toxic hazards and bio-hazards.

UNIT - V   CHARACTERISATION TECHNIQUES   [09]
Introduction to mechanical characterization. Optical microscopy - AFM, SPM, STM, SNOM, ESCA, SIMS, XRD, SEM, TEM.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01:   Describe the impact of engineering solutions in the Nano science and technology.*
- *C02:   Categorize the preparation methods.*
- *C03:   Explain about the patterning and lithography techniques.*
- *C04:   Develop the preparation environment and hazards.*
- *C05:   Improve the characterization techniques.*

Text Books:
1.   The Oxford hand book of "Nano science and technology", edited by A.V.Narlivar,2010.
2.   Encyclopedia of "Nano technology", Elwood D.Carlson, 2009.

Reference Books:
1.   Akhlesh Lakhtakia, The Hand Book Of Nano-technology, New Delhi,2007.
2.   N John Dinardo, "Nano-scale Characterization Of Surfaces And Interfaces",2nd Edition, Weinheim Cambridge,Willy-VCH,2000.
3.   Gregory.C.Timp, Nano-technology, Aip Press/Springer,1999.
4.   A.S Edelstein And R.C Cammearata ,Eds, Nano-materials; synthesis, properties and application, institute of physics publishing, Bristol and Philadelphia,1996.

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SEMESTER - VII

16ME767	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite : *Operations Research.*

Objective :

- *To understanding the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.*

UNIT - I   ENTREPRENEURSHIP   **[09]**

Entrepreneur - Types of entrepreneurs - Difference between entrepreneur and intrapreneur -Entrepreneurship in economic growth, factors affecting entrepreneurial growth. Case studies of successful entrepreneurs.

UNIT - II   MOTIVATION   **[09]**

Major motives influencing an entrepreneur - Achievement motivation training, self rating, business game, thematic apperception test - Stress management, entrepreneurship development programs -need, objectives.

UNIT - III   BUSINESS   **[09]**

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 - IV   FINANCING AND ACCOUNTING   **[09]**

Need - Sources of finance, term loans, capital structure, financial institution, management of working capital, costing, break even analysis, network analysis techniques of PERT/CPM - Taxation - Income tax, excise duty - Sales tax.

UNIT - V   SUPPORT TO ENTREPRENEURS   **[09]**

Sickness in small business - Concept, magnitude, causes and consequences, corrective measures - 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 completion of this course, the students will be able to

- *C01: Identify the Entrepreneurship growth.*
- *C02: Motivates to become an Entrepreneur.*
- *C03: Discuss the Business concepts.*
- *C04: Understand about   financing and accounting.*
- *C05: Plan to support Entrepreneurs.*

Text Books:

1. S.S.Khanka "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 2009 .
2. Hisrich R D and Peters M P, "Entrepreneurship" 6th Edition Tata McGraw-Hill, 2011.

Reference Books:

1. Kuratko & Hodgetts, "Enterprenuership – Theory, process and practices", Thomson Learning, 6th edition, 1999.
2. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis" Dream tech 2nd edition 2006.
3. Rabindra N. Kanungo "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998.

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SEMESTER- VIII

16ME861	INDUSTRIAL TRIBOLOGY	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisites : Design of Machine Elements, Fluid Mechanics and Machinery.
Objective   :

• *To attain the basic knowledge of surfaces, wear and lubrication theory.*

UNIT - I   SURFACES AND FRICTION   [09]

Topography of engineering surfaces - contact between surfaces - sources of sliding friction - adhesion - ploughing - energy dissipation mechanisms. friction characteristics of metals, ceramic materials and polymers - friction of lamellar solids - rolling friction - sources of rolling friction - measurement of friction.

UNIT - II   WEAR   [09]

Types of wear - Mechanisms of sliding wear - Abrasive wear - Materials for adhesive and abrasive wear situations - Corrosive wear - Surface fatigue wear situations - Brittle fracture - Wear of ceramics and polymers - Wear measurements.

UNIT - III   LUBRICANTS AND LUBRICATION TYPES   [09]

Types and properties of lubricants - Testing methods - Concepts of hydrodynamic, Hydrostatic, Elasto -hydrodynamic and boundary lubrication. Thin film and thick film lubrication - Methods of lubrication - Semi solid and solid lubricants.

UNIT - IV   FILM LUBRICATION THEORY   [09]
Fluid film in simple shear - Viscous flow between very close parallel plates - Shear stress variation Reynolds equation for film lubrication - High speed unloaded journal bearings - Loaded journal bearings - Reaction torque on the bearings - Virtual co-efficient of friction - The Sommerfeld diagram.

UNIT- V   SURFACE ENGINEERING AND MATERIALS FOR BEARINGS   [09]
Surface modifications - Transformation hardening, surface fusion - Thermo chemical processes - Surface coatings - Plating and anodizing - Fusion processes - Vapour phase processes - Materials for rolling element bearings - Materials for fluid film bearings - Materials for marginally lubricated and dry bearings.

                                                                      Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
  C01:   *Build the knowledge about friction.*
  C02:   *Understanding the different types of wear.*
  C03:   *Gain the knowledge about lubricants and types.*
  C04:   *Recognize the knowledge on film lubrication theory.*
  C05:   *Design the materials for bearing.*

Text Books:
1.   A.Harnoy "Bearing Design in Machinery" Marcel Dekker Inc, New York, 2003.
2.   Basu S.K. et. Al., "Fundamentals of Tribology" PHI Learning Private Limited, 2009.

Reference Books:
1.   M.M.Khonsari & E.R.Booser, "Applied Tribology",John Willey &Sons,New York, 2001.
2.   M.J.Neale (Editor), "Tribology Handbook", Newnes. Butter worth, Heinemann, U.K., 1995.
3.   A.Cameron, "Basic Lubrication theory", Longman, U.K.., 1981.
4.   E.P.Bowden and Tabor.D., "Friction and Lubrication", Heinemann Educational Books Ltd.,1974.

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SEMESTER – VIII

16ME862	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite : *Quality, Reliability and Maintenance Engineering.*
Objective :

- *To learn knowledge on design of product and their specifications.*

UNIT – I   INTRODUCTION   [09]

Introduction - characteristics of successful product development - who designs and develops product - duration and cost of product development - challenges of product development. Development process and organization - a generic development process - concept development - product development process flow - product development organizations. Product planning - product planning process - identifying customer needs - product specifications.

UNIT – II   CONCEPT DEVELOPMENT   [09]

Concept generation - activity of concept generation. Concept selection - method for choosing a concept. Concept screening - concept scoring - concept testing - steps of concept testing.

UNIT – III   PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN   [09]

Product architecture - introduction of product architecture - implications of product architecture - establishing product architecture - platform planning - related system level design issues. Industrial design - introduction - need - management of Industrial design process - quality of industrial design.

UNIT – IV   DESIGN FOR MANUFACTURING , PROTOTYPING AND ROBUST DESIGN   [09]

Design for manufacturing - definition - estimation of manufacturing costs - methods of reducing costs and other supporting production cost. Prototyping - principles of prototyping - prototyping technologies - planning for prototyping. Robust design – introduction - steps for robust design - concurrent engineering.

UNIT – V   PATENTS AND INTELLECTUAL PROPERTY, PRODUCT DEVELOPMENT ECONOMICS   [09]

Patents and intellectual property - what is intellectual property - steps for patents and intellectual property. Product development economics - introduction - elements of economic analysis.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Remember the theory of design.*
- *C02: Describe the concept development.*
- *C03: Categorize the product architecture and industrial design.*
- *C04: Synthesis the prototyping and robust design.*
- C05: *Analyze the product development economics.*

Text Books:

1. Karl, T.Ulrich, Steven D.Eppinger, and Anita Goyal, "Product Design and Development", MHI, 2009.
2. George Dietor, "A Material and Processing Approach", McGraw Hill, 2000.

Reference Books:

1. Kevin Otto, Kristin Wood, "Product Design", Pearson Education, 2008.
2. Imad Moustapha, "Concurrent Engineering in Product Design and Development", New Age International, 2003.
3. A. K. Chitale, R. C. Gupta, "Product Design and Manufacturing", PHI Private Ltd., 2007.
4. Pahl and Pitz, "Engineering Design Process", Springer, 2007.

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<u>SEMESTER - VIII</u>

16ME863	VIBRATION AND NOISE CONTROL	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisites : Applied Physics, Dynamics of Machinery.

Objective :

- *To Learn Concept of Vibration Isolation And Noise Control.*

UNIT – I   BASICS OF VIBRATION   **[09]**

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 – II   VIBRATION OF CONTINUOUS SYSTEMS   **[09]**

Vibration of continuous systems: exact methods, boundary value problem, eigen value problem, axial vibration of rods, transverse vibration of beams, response of system by modal analysis, general elastic waves, approximate methods to analyze system, different methods like Rayleigh's energy method, Rayleigh-Ritz method, Dunkerleys method.

UNIT – III   CONTROL TECHNIQUES   **[09]**

Vibration isolation, tuned absorbers, untuned 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 – IV   BASICS OF NOISE   **[09]**

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

UNIT – V   INDUSTRIAL NOISE AND CONTROL   **[09]**

Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine accessory contributed noise, transmission noise.

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

     C01: Build the basic knowledge of vibration.
     C02: Understand the vibration of continuous system.
     C03: Categorize the control techniques.
     C04: Identify the basics of noise.
     C05: *Analyze the industrial noise and control.*

Text Books:

1. Ambekar A.G. "Mechanical Vibrations and Noise Engineering" Prentice Hall of India Pvt. Ltd,2010.
2. Singiresu S.Rao - "Mechanical Vibrations" - Pearson Education, - 2010.

Reference Books:

1. Rao V. Dukkipati & Srinivas J. "Mechanical Vibrations" - Prentice Hall of India Pvt. Ltd, 2008
2. Kewal Pujara "Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 1992.
3. Rao, J.S., & Gupta, K. – "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1984.
4. Theory of Vibrations with applications – W. T. Thomson, CBS Publishers, 1980.

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SEMESTER - VIII

16ME864	**THERMAL TURBO MACHINES**	L T P C	
	ELECTIVE	3 0 0 3	

Prerequisites   *: Engineering Thermodynamics, Thermal Engineering.*

Objective   *:*

• *To understand the fundamentals of thermal turbo machines.*

UNIT - I   INTRODUCTION TO TURBO MACHINES   [09]

Turbo machines - fans, blowers and compressors - stages, energy transfer between fluid and rotor - stage velocity triangles - general energy equation - modified to turbo machines - compression and expansion process - velocity triangles - work - T-S and H-S diagram - total-to-total and total-to-static efficiencies.

UNIT - II   CENTRIFUGAL FANS AND COMPRESSORS   [09]

Definition - selection and classifications - types of blading design - velocity triangles - stage parameters - flow analysis in impeller blades - design parameter - volute and diffusers - efficiencies and losses - fan noises - causes and remedial measures. Centrifugal compressors: constructional details - stage velocity triangles - stage work - stage pressure rise - stage efficiency - degree of reaction - slip factor - H-S diagram - efficiencies - performance characteristics.

UNIT - III   AXIAL FANS AND COMPRESSORS   [09]

Definition and classifications - stage parameters - types of fan stages - performance characteristics - cascade of blades - cascade tunnel - blade geometry - cascade variables - energy transfer and loss in terms of lift and drag. Axial flow compressors: definition and classifications - constructional details - stage velocity triangles - stage work - stage pressure rise - H-S diagram - stage efficiencies and losses - degree of reaction - radial equilibrium - surging and stalling - performance characteristics.

UNIT - IV   AXIAL FLOW TURBINES   [09]

Construction details - 90° IFR turbine - stage work - stage velocity triangles - stage pressure rise - impulse and reaction stage - effect of degree of reaction - H-S diagram - efficiencies and losses - performance characteristics.

UNIT - V   RADIAL FLOW TURBINES AND WIND TURBINES   [09]

Constructional details - stage velocity triangles - H-S diagram - stage efficiencies and losses - performance characteristics - wind turbines: definition and classifications - constructional details - horizontal axis wind turbine - power developed - axial thrust - efficiency.

                                                                               Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

  C01: *Recognize the turbo machines.*
  C02: *Describe the centrifugal fans and compressors.*
  C03: *Categorize the axial fans and compressors.*
  C04: *Construct the axial flow turbines.*
  C05: *Perform the radial flow turbines and wind turbines.*

Text Books:

1.   Yahya, S.M., "Turbines, Compressors and Fans", Tata McGraw-Hill Publishing Company,1996.
2.   Dixon, S.L., "Fluid Mechanics, Thermodynamics of Turbo-machines", 5th Edition, Pergamon Press, 1990.

Reference Books:

1.   Kadambi, V. and Manohar Prasad, "An Introduction to energy conversion - Vol. III", Turbomachines, Wiley Eastern India Ltd, 1977.
2.   Shepherd, D.H., "Principles of Turbo machinery", The Macmillan Company, 1969.
3.   Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First

Indian Edition – 2007.

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SEMESTER - VIII

16ME865	WELDING TECHNOLOGY	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite   : *Manufacturing Technology-I.*
Objectives   :
- *To learn basic welding principles.*
- *To build on the fundamental skills in Welding.*

UNIT - I   **INTRODUCTION**   **[09]**

Gas welding: gases - setup of equipment - flame characteristics - different kinds of flame and their areas of application - weld quality - applications - variants of oxy-gas welding.
Manual metal arc welding: process - power sources - function of flux covering - different type of electrodes and their application - electrode designations - defects in welding.

UNIT - II   **SUBMERGED ARC WELDING**   **[09]**

The process - power sources - advantages – limitations - process variables and their effects - SAW consumables significance of flux-metal combination - modern developments - applications - defects.

UNIT - III   **GAS TUNGSTEN ARC WELDING**   **[09]**

Electrode polarity - shielding gas - use of D.C. suppressors - arc starting and stopping - choice of filler metal composition - use of pulsed arc and GTA spot welding - other recent developments - applications.

UNIT - IV   **GAS METAL ARC WELDING**   **[09]**

Considerations of electrodes polarity - shield gas and filler composition. Nature of conditions of spray transfer - difficulties for thin sheet. Dip transfer and CO_2 welding. Flux cored and pulsed MIG welding - other recent developments - applications.

UNIT - V   **ADVANCED WELDING PROCESSES**   **[09]**

Solid state welding processes - high energy beam welding - electro slag welding - plasma arc welding principles of operation - advantages - limitations - applications.

                                                   Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
> C01: *Remember the Gas welding equipment.*
> C02: *Understand about the submerge arc welding.*
> C03: *Construct the gas tungsten arc welding.*
> C04: *Categorize the gas metal arc welding.*
> C05: *Implement the advanced welding processes.*

Text Books:
1. Parmer R.S., "Welding Processes and Technology", Khanna Publishers, 2010.
2. AWS - Welding Hand Book, 8th Edition, Volume-1 "Welding Process", 1998.

Reference Books:
1. Schwartz M.M. "Metals Joining Manual", McGraw Hill Books. 1979.
2. Tylecote R.F., "The Solid Phase Welding of Metals", Edward Arnold Publishers Ltd.   London, 1968.
3. Nadkarni S.V., "Modern Arc Welding Technology", Oxford IBH Publishers. 1996.
4. Christopher Davis, "Laser Welding - Practical Guide", Jaico Publishing House, 1994.

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<u>SEMESTER - VIII</u>

16ME866	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisites : Manufacturing Technology-II, Computer Aided Manufacturing.

Objectives :

- *To learn about the process planning concepts.*
- *To make cost estimation for various products after process planning.*

UNIT – I   WORK STUDY AND ERGONOMICS   [09]

Method study – definition – objectives-motion economy – principles – tools and techniques – applications – work measurements – purpose - use – procedure - tools and techniques – standard time – ergonomics – principles – applications.

UNIT – II   PROCESS PLANNING   [09]

Definition – objective – scope – approaches to process planning- process planning activities – finished part requirements-operating sequences – machine selection – material selection parameters – set of documents for process planning – developing manufacturing logic and knowledge – production time calculation – selection of cost optimal processes.

UNIT – III   COST ESTIMATION AND COST ACCOUNTING   [09]

Objective of cost estimation – costing – cost accounting – difference between cost estimation and cost accounting-classification of cost –difference between financial accounting and cost accounting-methods of costing- Elements of cost.

UNIT – IV   TYPES OF ESTIMATION, STANDARD DATA AND ALLOWANCES   [09]

Types of estimates – materials available to develop estimate-methods of estimates – realistic estimates –data requirements and sources – collection of cost – estimating procedure –allowances in estimation.

UNIT – V   PRODUCTION COST ESTIMATION   [09]

Estimation of material cost, labour cost and over heads, allocation of overheads – estimation for different types of jobs-estimation of machining time.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Understand the work study and ergonomics.*
- *C02: Evaluate the process planning.*
- *C03: Apply the cost estimation and cost accounting.*
- *C04: Assess the types of estimation, standard data and allowances.*
- C05: *Choose the production cost estimation.*

Text Books:

1. G.B.S.Narang and V.Kumar, "Production and Costing", Khanna Publishers, 2005.
2. Sinha.B.P., "Mechanical Estimating and Costing", Tata McGraw-Hill, Publishing Co., 1995.

Reference Books:

1. Russell.R.S and Tailor, B.W, "Operations Management", PHI, 4th Edition, 2003.
2. Chitale.A.V. and Gupta.R.C., "Product Design and Manufacturing", PHI, 2nd Edition, 2002.
3. Phillip.F Ostwalal and Jairo Munez, "Manufacturing Processes and systems", John Wiley, 9th Edition, 1998.

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SEMESTER - VIII

16ME867	OPTIMIZATION IN DESIGN	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisites :　Design of Machine Elements, Operations Research.

Objective　:

- *To learn the optimization techniques and apply for the design of loaded members.*

UNIT – I　UNCONSTRAINED OPTIMIZATION TECHNIQUES　　　　　**[09]**

Introduction to optimum design - general principles of optimization – problem formulation & their classifications - single variable and multivariable optimization, techniques of unconstrained minimization – golden section, random, pattern and gradient search methods – interpolation methods.

UNIT – II　CONSTRAINED OPTIMIZATION TECHNIQUES　　　　　**[09]**

Optimization with equality and inequality constraints - direct methods – indirect methods using penalty functions, Lagrange multipliers - geometric programming.

UNIT – III　DYNAMIC PROGRAMMING　　　　　**[09]**

Introduction - multi stage optimization - dynamic programming methods – stochastic programming- multi objective optimization.

UNIT – IV　UNCONVENTIONAL OPTIMIZATION TECHNIQUES　　　　　**[09]**

Genetic algorithms, Simulated Annealing and Ant Colony techniques; Neural network & Fuzzy logic principles in optimization.

UNIT – V　APPLICATIONS　　　　　**[09]**

Structural applications - design applications - design of simple truss members - design of simple axial, transverse loaded members for minimum cost and weight - design of shafts and torsionally loaded members - design of springs.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01:　Understand the unconstrained optimization techniques.*
- *C02:　Remember the constrained optimization techniques.*
- *C03:　Apply the dynamic programming.*
- *C04:　Formulate the unconventional optimization techniques.*
- *C05:　Assess the design applications.*

Text Books:

1. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited,4 th Edition, New Delhi, 2007.
2. A.Ravindran, K.M.Ragsdell and G.V.Reklaitis, "Engineering Optimization, Methods and applications" John Wiley Puplications, 2nd Edition, Re printed 2006.

Reference Books:

1. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, Re printed 2003.
2. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison- Wesley, New York, re printed 2003.
3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. Ltd. 2006.
4. Purna Chandra Biswal, "Optimization in Engineering", SCITECH publications, 2009.

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<u>SEMESTER - VIII</u>

16ME868	INDUSTRIAL ROBOTICS	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite *: Computer Aided Manufacturing.*

Objective *:*

- *To learn the principles of Robotics and application in industry.*

UNIT – I   FUNDAMENTALS OF ROBOTICS   **[09]**

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.

UNIT – II   ROBOT DRIVE SYSTEMS AND END EFFECTORS   **[09]**

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

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 – III   SENSORS AND MACHINE VISION   **[09]**

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 (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors. 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.

UNIT – IV   ROBOT KINEMATICS AND ROBOT PROGRAMMING   **[09]**

Forward Kinematics, Inverse Kinematics and Differences - Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) - DH matrices - Deviations and Problems.

Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming - Motion Commands, Sensor Commands, End effecter commands and Simple Programs.

UNIT – V   IMPLEMENTATION AND ROBOT ECONOMICS   **[09]**

RGV, AGV; Implementation of Robots in Industries - Various Steps; Safety Considerations for Robot Operations;

Economic Analysis of Robots - Pay back Method, EUAC Method, Rate of Return Method.

                                                                      Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

- *C01: Understand the fundamentals of robotics.*
- *C02: Apply the concepts of Robot drive systems and end effectors.*
- *C03: Gain the Knowledge of sensors and machine vision.*
- *C04: Construct the robot kinematics and robot programming.*
- *C05: Apply the implementation and robot kinematics.*

Text Books:
1. M.P.Groover, "Industrial Robotics – Technology, Programming and Applications", McGraw-Hill,2001.
2. Yoram Koren, "Robotics for Engineers", McGraw-Hill Book Co., 1992.

Reference Books:
1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw-Hill Book Co., 1987.
2. Janakiraman.P.A., "Robotics and Image Processing", Tata McGraw-Hill, 1995.

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<u>**SEMESTER - VIII**</u>

16ME869	PRESSURE VESSEL AND PIPING DESIGN	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisites: *Fluid Mechanics and Machinery, Strength of Materials.*

Objective   :

• *To learn the principles of pressure vessels and piping design.*

UNIT – I   INTRODUCTION   **[09]**

Development of pressure vessel construction codes - pressure vessel design overview - methods for determining stresses - terminology – applications.

UNIT – II   STRESSES IN PRESSURE VESSELS   **[09]**

Stresses in a circular ring, cylinder - membrane stress analysis of vessel shell - components - cylindrical shells, spherical shells, torispherical heads, conical heads - thermal stresses - discontinuity of stresses in pressure vessels.

UNIT – III   DESIGN OF VESSELS   **[09]**

Design of tall cylindrical self supporting process columns - supports for short vertical vessels - stress concentration at a variable thickness transition section in a cylindrical vessel, circular hole, elliptical openings. Theory of reinforcement - pressure vessel design.

UNIT – IV   BUCKLING AND FRACTURE ANALYSIS IN VESSELS   **[09]**

Buckling phenomenon - elastic Buckling of circular ring and cylinders under external pressure - collapse of thick walled cylinders or tubes under external pressure -effect of supports - elastic buckling of cylinders - buckling under combined external pressure and axial loading.

UNIT – V   PIPING   **[09]**

Introduction – design procedure - flow diagram - Piping layout and piping stress analysis.

                                                              Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to

    C01: Understand the knowledge about pressure vessel.
    C02: Categorize the stresses acting in pressure vessels.
    C03: Create the design of vessels.
    C04: Analyze the Buckling and fracture in vessels.
    C05: Implement the design procedure for piping layout.

Text Books:

1.   John F. Harvey, "Pressure Vessel Design", CBS publishers, 2007.
2.   Henry H. Bedner, "Pressure Vessels", Design Hand Book, CBS publishers, 2007.

Reference Books:

1.   D. Broek, Elementary Engineering Fracture Mechanics, Sijthoff & Noordhoff International publishers, 1986.
2.   R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, Concepts & Applications of Finite Element Analysis, John Wiley & Sons Scheme, 2007.
3.   William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels. and Piping", Presented at ASME Pressure Vessels and Piping Conference, 1997.

SEMESTER - VIII

16ME871	INTERNAL COMBUSTION ENGINES	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisites: *Thermal Engineering, Thermodynamics.*

Objective :

- *To attain the basic knowledge of internal combustion engines and various methods to control the pollution.*

UNIT - I   SPARK IGNITION ENGINES   [09]

Introduction - mixture requirements - carburetors - fuel injection systems - single point and multi point injection - stages of combustion - normal, abnormal combustion - factors affecting knock - measurement of knock - anti knock agent - types of combustion chambers.

UNIT - II   COMPRESSION IGNITION ENGINES   [09]

Introduction - states of combustion - direct, indirect injection systems - combustion chambers - fuel spray behaviors - spray structure, spray penetration, evaporation - air motion.

UNIT - III   ALTERNATIVE FUELS   [09]

Introduction - Methanol, ethanol, hydrogen, natural gas, biogas, bio diesel, liquefied petroleum gas - properties, suitability, engine modifications, merits and demerits as fuels.

UNIT - IV   EMERGING ENGINE TECHNOLOGIES   [09]

Introduction - Lean burn engines - stratified charge engines - gasoline direct injection engine - homogeneous charge compression ignition - plasma ignition - zero emission vehicle, variable compression ratio engines, and turbocharged engines.

UNIT - V   POLLUTANT FORMATION AND CONTROL   [09]

Pollutant - sources and types - formation of NOx - hydrocarbon emission mechanism - carbon monoxide formation - particulate emissions - effect of pollutant, emission standards - methods of controlling emissions - catalytic converters, particulate traps.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- C01: *Determine the performance and combustion characteristics of SI engines.*
- C02: *Understand the performance and combustion characteristics of CI engines.*
- C03: *Identify the usage of alternate fuels and power plants for automobiles.*
- C04: *Enhance the efficiency and performance of IC engines.*
- C05: *Determine the emissions from SI and CI engines and its controlling techniques.*

Text Books :

1. Ganesan V., "Internal Combustion Engines", 4th edn., Tata McGraw Hill Pub. Co. Ltd., 2012.

2. Gupta H. N., "Internal Combustion Engines", PHI Learning Private Limited, 2012.

Reference Books :

1. Willard W. Pulkrabek. "Engineering fundamentals of the Internal Combustion Engine", PHI Learning Private Limited, 2008.

2. John B.Heywood, "Internal combustion engines fundamentals", McGraw Hill, 1988.

3. Mathur R.B and Sharmal R.P., "Internal combustion engines", 2011.

4. Mohanty R.K., "A text book of internal combustion engines", standard book House, 2007.

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SEMESTER – VIII

16ME872	UNCONVENTIONAL MACHINING PROCESSES	L	T	P	C
	ELECTIVE	3	0	0	3

Prerequisite : Manufacturing Technology – II

Objectives :
- *To learn about the functions and principles of unconventional machining processes.*
- *To gain proficiency of views in machining processes.*

UNIT - I   INTRODUCTION   [09]

Need for non-traditional machining methods-Classification of Unconventional machining processes – considerations in process selection. Materials. Economic consideration- applications and limitations, recent development.

UNIT - II   MECHANICAL PROCESSES   [09]

Abrasive jet machining, Water jet machining and abrasive water jet machining Basic principles, equipments used, process variables, mechanics of metal removal, MRR, application and limitations. Ultrasonic Machining. Working Principles – equipment used – Process parameters – MRR- Applications.

UNIT - III   ELECTRO – CHEMICAL METAL REMOVAL PROCESSES   [09]

Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and de burring process, metal removal rate in ECM, Tool design, Surface finish and accuracy economic aspects of ECM – Simple problems for estimation of metal removal rate. Fundamentals of chemical, machining, advantages and applications. Maskants – etchants.

UNIT - IV   THERMAL-ELECTRIC METAL REMOVAL PROCESSES   [09]

General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting processes – Power circuits for EDM, Mechanics of metal removal , Process parameters, selection of tool electrode and dielectric fluids, surface finish, machining accuracy and other characteristics of spark eroded surface ,magnetic abrasive finishing, abrasive flow finishing.

UNIT - V   THERMAL METAL REMOVAL PROCESSES   [09]

Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes –General Principle and application of laser beam machining – thermal features, cutting speed and accuracy of cut. Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries.

Total = 45 Periods

Course Outcomes: On completion of this course, the students will be able to
- *C01: Gain the knowledge on unconventional machining processes.*
- *C02: Acquire the various mechanical machining processes.*
- *C03: Build the electro-chemical metal removal processes.*
- *C04: Illustrate the thermal-electric metal removal processes.*
- *C05: Understand the thermal metal removal processes.*

Text Books :
1. P.K.Mishra "Non Conventional Machining" Narosa Publishing House, New Delhi (2009).
2. Pandey P.C.and Shan H.S. 'Modern Machining Processes' Tata McGraw-Hill, New Delhi (2008).

Reference Books :
1. Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi (2002) ISBN 81-7764-294-4.
2. Benedict. G.F. "Nontraditional Manufacturing Processes" Marcel Dekker Inc., New York (1987).
3. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi (1980).
4. Mc Geough, "Advanced Methods of Machining" Chapman and Hall, London (1998).

SEMESTER - VIII

		L T P C
16ME873	**FLEXIBLE MANUFACTURING SYSTEMS**	3 0 0 3
	ELECTIVE	

Prerequisite *: Computer Aided Manufacturing*

***Objective* :**
• *To learn basic concepts, components, automated material handling systems and control using computers.*

UNIT – I　　INTRODUCTION　　　　　　　　　　　　　　　　[09]

Definition, need, types and configuration of FMS - types of flexibilities and performance measures. Economic justification of FMS - development and implementation of FMS- planning phases, integration, system configuration, FMS layouts, simulation.

UNIT – II　　AUTOMATED MATERIAL HANDLING AND STORAGE　　　[09]

Functions – types - analysis of material handling systems, primary and secondary material handling systems-conveyors, automated guided vehicles - working principle, types, and traffic control of AGVS. role of robots in material handling. Automated storage systems- storage system performance - AS/RS-carousel storage system, WIP storage systems, interfacing handling and storage with manufacturing.

UNIT – III　　COMPUTER CONTROL OF FMS　　　　　　　　　　[09]

Planning, scheduling and computer control of FMS, Hierarchy of computer control, supervisory computer. Features of DNC systems - communication between DNC computer and machine control unit.

UNIT – IV　　COMPUTER SOFTWARE, SIMULATION AND DATA BASE OF FMS　　[09]

System issues, types of software – specification and selection- trends application of simulation and its software, Manufacturing Data systems planning - FMS data base. Modeling of FMS- analytical, heuristics, queuing, simulation and petrinets modeling techniques.

UNIT – V　　SCHEDULING OF FMS　　　　　　　　　　　　　　[09]

Scheduling of operations on a single machine- two machine flow shop scheduling, two machine job shop scheduling, - three machine flow shop scheduling- scheduling 'm' operations on 'n' machines, knowledge based scheduling, scheduling rules, tool management of FMS, material handling system schedule.

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Course Outcomes: On completion of this course, the students will be able to
- *C01: Gain the knowledge about basic concepts of FMS.*
- *C02: Build the knowledge about Automated Material handling and storage.*
- *C03: Develop the knowledge about Computer control of FMS.*
- *C04: Apply the knowledge on computer software and simulation and database.*
- C05: *Evaluate the scheduling of FMS.*

Text Books:
1. Groover. M. P., 'Automation production systems and computer integrated manufacturing', Prentice hall of India pvt.Ltd, 2007.
2. Jha, N.K. "Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 2007.

Reference Books:
1. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd.,New Age International Ltd., 2008.
2. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems recent development", Elsevier Science, 1995.
3. Buffa .E.S. and Sarin, 'Modern Production and Operations Management', Wiley Eastern, 1987.