GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore - 641 013

Curriculum and Syllabi For

MECHANICAL ENGINEERING

(Full Time)

2016

CBCS

Regulations

OFFICE OF CONTROLLER OF EXAMINATIONS
GOVERNMENT COLLEGE OF TECHNOLOGY
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GOVERNMENT COLLEGE OF TECHNOLOGY

((An Autonomous Institution Affiliated to Anna University)
Coimbatore - 641 013

VISION AND MISSION OF THE INSTITUTION

VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind

MISSION

- To achieve Academic excellence through innovative teaching and learning practices.
- To enhance employability and entrepreneurship
- To improve the research competence to address societal needs
- To inculcate a culture that supports and reinforces ethical, professional behaviors for a harmonious and prosperous society

GOVERNMENT COLLEGE OF TECHNOLOGY

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DEPARTMENT OF MECHANICAL ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Mechanical Engineering Education, Entrepreneurship and Innovation.

MISSION

- To impart total quality education through effective hi-tech teaching-learning techniques and department-industries collaboration.
- To mold the young dynamic potential minds to emerge as full-fledged future professionals so as to achieve top ten ranking status in the national level.
- To achieve international standards to fulfill the Government's "Make In India" industrial policy through innovation and research.

GOVERNMENT COLLEGE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Programme Educational Objectives are designed based on the department mission

The PEO's are to facilitate graduating students to

PEO 1: Acquire basic knowledge and expertise necessary for professional practice in mechanical engineering for higher studies and research

PEO 2: Attain and practice technical skills to identify, analyze and solve complex problems and issues related to mechanical engineering

PEO 3: Possess a professional attitude as an individual or a team member with consideration for society, professional ethics, environmental factors and motivation for life-long learning

GOVERNMENT COLLEGE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAMME OUTCOMES (POs)

Students pursuing in the Mechanical Engineering (Department) Programme should at the time of their graduation be in possession of the following

PO 1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO 2: **Problem analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO 3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal and environmental considerations

PO 4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO 5: **Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO 6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge and need for the sustainable development

PO 8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: **Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings

PO 10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large such as being able to comprehend and write effective reports and design documentation and make effective presentations and give and receive clear instructions.

PO 11: **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, manage projects and in multidisciplinary environments.

PO 12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

GOVERNMENT COLLEGE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAM SPECIFIC OUTCOMES (PSO'S)

Graduates of Mechanical Engineering should be able:

PSO – 1: To develop the capability for synthesizing data and technical concepts so as to emerge as a successful engineer /administrator in industry to meet the needs of society and the country.

PSO – 2: To exhibit a sound foundation in mathematical, scientific and engineering areas necessary for achieving excellence in solving and analysing engineering problems to face new challenges for multi-disciplinary projects in higher /graduate studies.

PSO – 3: To fulfill the ambition of life-long learning and apply professional ethics and codes of professional practices during their career.

GOVERNMENT COLLEGE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

COMPONENTS OF THE CURRICULUM

Course Component	Curriculum Content (% of total number of credits of the program)	Total number of contact hours	Total number of credits
Basic Sciences	16	555	29
Engineering Sciences	17	570	31
Humanities and Social Sciences	7	210	12
Program Core	35	1185	65
Program Electives	10	270	18
Open Electives	5	135	9
Projects	7	360	12
Internships/Seminars	--	--	--
Any other(Please specify)	3	180	6
Total number of Credits			182

B.E.MECHANICAL ENGINEERING

CBCS 2016 REGULATIONS

FIRST SEMESTER

Sl. No.	Course Code	Course Title	Category	Continuous Assessment Marks	End Sem Marks	Total Marks	Credits			
							L	T	P	C
		THEORY								
1	16MHS1Z1	Communication Skills in English	HS	50	50	100	2	2	0	3
2	16MBS1Z2	Engineering Mathematics I	BS	50	50	100	3	2	0	4
3	16MBS103	Applied Physics	BS	50	50	100	3	0	0	3
4	16MBS104	Engineering Chemistry	BS	50	50	100	3	0	0	3
5	16MES105	Basics of Electrical and Electronics Engineering	ES	50	50	100	3	0	0	3
		PRACTICAL								
6	16MBS106	Physics Laboratory	BS	50	50	100	0	0	4	2
7	16MES107	Engineering Graphics	ES	50	50	100	2	0	4	4
		TOTAL		350	350	700	16	4	8	22

SECOND SEMESTER

Sl. No.	Course Code	Course Title	Category	Continuous Assessment Marks	End Sem Marks	Total Marks	Credits			
							L	T	P	C
		THEORY								
1	16MHS2Z1	Technical English	HS	50	50	100	2	2	0	3
2	16MBS2Z2	Engineering Mathematics II	BS	50	50	100	3	2	0	4
3	16MBS2Z3	Materials Science	BS	50	50	100	3	0	0	3
4	16MHS2Z4	Environmental Science and Engineering	HS	50	50	100	3	0	0	3
5	16MES2Z5	Programming in C	ES	50	50	100	3	0	0	3
6	16MES206	Engineering Mechanics	ES	50	50	100	3	2	0	4
		PRACTICAL								
7	16MBS207	Chemistry Laboratory	BS	50	50	100	0	0	4	2
8	16MES208	Workshop Practice	ES	50	50	100	0	0	4	2
9	16MES2Z9	Programming in C Laboratory	ES	50	50	100	0	0	4	2
		TOTAL		450	450	900	17	6	12	26

THIRD SEMESTER

Sl. No.	Course Code	Course Title	Category	Continuous Assessment Marks	End sem Marks	Total Marks	Credits			
							L	T	P	C
		THEORY								
1	16MBS3Z1	Engineering Mathematics III	BS	50	50	100	3	2	0	4
2	16MES302	Strength of Materials	ES	50	50	100	3	0	0	3
3	16MES303	Electrical Machines and Drives	ES	50	50	100	3	0	0	3
4	16MPC304	Manufacturing Technology I	PC	50	50	100	3	0	0	3
5	16MPC305	Engineering Metallurgy	PC	50	50	100	3	0	0	3
6	16MPC306	Fluid Mechanics and Machinery	PC	50	50	100	3	0	0	3
		PRACTICAL								
7	16MES307	Electrical Engineering Laboratory	ES	50	50	100	0	0	4	2
8	16MES308	Strength of Materials and Fluid Machinery Laboratory	ES	50	50	100	0	0	4	2
		TOTAL		400	400	800	18	2	8	23

FOURTH SEMESTER

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End sem Marks	Total Marks	Credits			
							L	T	P	C
		THEORY								
1	16MBS401	Numerical Methods	BS	50	50	100	3	2	0	4
2	16MES402	Applied Electronics and Microprocessors	ES	50	50	100	3	0	0	3
3	16MPC403	Kinematics of Machines	PC	50	50	100	3	0	0	3
4	16MPC404	Engineering Thermodynamics	PC	50	50	100	3	0	0	3
5	16MPC405	Metrology and Measurements	PC	50	50	100	3	0	0	3
6	16MPC406	Manufacturing Technology II	PC	50	50	100	3	0	0	3
		PRACTICAL								
7	16MPC407	Machine Drawing and Drafting Laboratory	PC	50	50	100	0	0	4	2
8	16MPC408	Metallurgy and Metrology Laboratory	PC	50	50	100	0	0	4	2
		TOTAL		400	400	800	18	2	8	23

FIFTH SEMESTER

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End sem Marks	Total Marks	CREDITS			
							L	T	P	C
		THEORY								
1	16MPC501	Design of Machine Elements	PC	50	50	100	3	2	0	4
2	16MPC502	Thermal Engineering	PC	50	50	100	3	0	0	3
3	16MPC503	Dynamics of Machines	PC	50	50	100	3	0	0	3
4	16MPC504	Turbo Machines	PC	50	50	100	3	0	0	3
5	16MPC505	Hydraulics and Pneumatic Controls	PC	50	50	100	3	0	0	3
6	E-I	Elective : I	OE	50	50	100	3	0	0	3
		PRACTICAL								
7	16MEE507	Skill Development Practices	EEC	100	0	100	0	0	4	2
8	16MPC508	Thermal Engineering Laboratory I	PC	50	50	100	0	0	4	2
9	16MPC509	Manufacturing Technology Laboratory	PC	50	50	100	0	0	4	2
		TOTAL		500	400	900	18	2	12	25

SIXTH SEMESTER

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End sem Marks	Total Marks	Credits			
							L	T	P	C
		THEORY								
1	16MPC601	Computer Aided Design and Manufacturing	PC	50	50	100	3	0	0	3
2	16MPC602	Operations Research	PC	50	50	100	3	0	0	3
3	16MPC603	Design of Transmission systems	PC	50	50	100	3	2	0	4
4	16MPC604	Heat and Mass Transfer	PC	50	50	100	3	0	0	3
5	E-II	Elective : II	OE	50	50	100	3	0	0	3
6	E-I	Elective : I	PE	50	50	100	3	0	0	3
		PRACTICAL								
7	16MPC607	Thermal Engineering Laboratory II	PC	50	50	100	0	0	4	2
8	16MPC608	Dynamics and Instrumentation Laboratory	PC	50	50	100	0	0	4	2
9	16MEE609	Mini Project	EEC	50	50	100	0	0	8	4
		TOTAL		450	450	900	18	2	16	27

SEVENTH SEMESTER

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End sem Marks	Total Marks	Credits			
							L	T	P	C
		THEORY								
1	16MHS701	Engineering Economics and Management	HS	50	50	100	3	0	0	3
2	16MPC702	Finite Element analysis	PC	50	50	100	3	0	0	3
3	E-III	Elective : III	OE	50	50	100	3	0	0	3
4	E-II	Elective : II	PE	50	50	100	3	0	0	3
5	E-III	Elective : III	PE	50	50	100	3	0	0	3
6	E-IV	Elective : IV	PE	50	50	100	3	0	0	3
		PRACTICAL								
7	16MEE707	Simulation Laboratory	EEC	50	50	100	0	0	4	2
8	16MEE708	CAD/CAM Laboratory	EEC	50	50	100	0	0	4	2
		TOTAL		400	400	800	18	0	8	22

EIGHTH SEMESTER

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End sem Marks	Total Marks	Credits			
							L	T	P	C
		THEORY								
1	E-V	Elective : V	PE	50	50	100	3	0	0	3
2	E-VI	Elective : VI	PE	50	50	100	3	0	0	3
		PRACTICAL								
3	16MEE801	Project	EEC	50	50	100	0	0	16	8
		TOTAL		150	150	300	6	0	16	14

TOTAL NO. OF CREDITS: 182

PROFESSIONAL ELECTIVES

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End sem Marks	Total Marks	Credits			
							L	T	P	C
1	16MPEX01	Refrigeration and Air Conditioning	PE	50	50	100	3	0	0	3
2	16MPEX02	Manufacturing planning and Control	PE	50	50	100	3	0	0	3
3	16MPEX03	Power Plant Engineering	PE	50	50	100	3	0	0	3
4	16MPEX04	Design of Jigs, Fixtures and Press Tools	PE	50	50	100	3	0	0	3
5	16MPEX05	Design for Manufacture	PE	50	50	100	3	0	0	3
6	16MPEX06	Mechatronics	PE	50	50	100	3	0	0	3
7	16MPEX07	Computational Fluid Dynamics	PE	50	50	100	3	0	0	3
8	16MPEX08	Design of Rotating Machinery	PE	50	50	100	3	0	0	3
9	16MPEX09	Gas Dynamics and Jet Propulsion	PE	50	50	100	3	0	0	3
10	16MPEX10	Industrial Robotics	PE	50	50	100	3	0	0	3
11	16MPEX11	Plant Layout and Material Handling	PE	50	50	100	3	0	0	3
12	16MPEX12	Mechanical Vibrations	PE	50	50	100	3	0	0	3
13	16MPEX13	Newer Production Processes	PE	50	50	100	3	0	0	3
14	16MPEX14	Lean Manufacturing	PE	50	50	100	3	0	0	3
15	16MPEX15	Welding Technology	PE	50	50	100	3	0	0	3
16	16MPEX16	Theory of Metal cutting	PE	50	50	100	3	0	0	3
17	16MPEX17	Robust Design	PE	50	50	100	3	0	0	3
18	16MPEX18	Additive Manufacturing	PE	50	50	100	3	0	0	3
19	16MPEX19	Entrepreneurship Development	PE	50	50	100	3	0	0	3

OPEN ELECTIVES

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End sem Marks	Total Marks	Credits			
							L	T	P	C
1	16AOEX01	NanoScience and Technology	OE	50	50	100	3	0	0	3
2	16AOEX02	Material Characterizations	OE	50	50	100	3	0	0	3
3	16AOEX03	Electrochemical Technology	OE	50	50	100	3	0	0	3
4	16AOEX04	Polymer Technology	OE	50	50	100	3	0	0	3
5	16COEX05	Disaster Management and Mitigation	OE	50	50	100	3	0	0	3
6	16COEX06	Environmental Management	OE	50	50	100	3	0	0	3
7	16COEX07	Town Planning and Architecture	OE	50	50	100	3	0	0	3
8	16MOEX08	Total Quality Management for Engineers	OE	50	50	100	3	0	0	3
9	16MOEX09	Composite Materials	OE	50	50	100	3	0	0	3
10	16MOEX10	Automobile Engineering	OE	50	50	100	3	0	0	3
11	16EOEX11	Renewable Energy Sources and Technology	OE	50	50	100	3	0	0	3
12	16EOEX12	Smart Grid Technology	OE	50	50	100	3	0	0	3
13	16LOEX13	Principles of Communication	OE	50	50	100	3	0	0	3
14	16LOEX14	Microcontrollers and its Applications	OE	50	50	100	3	0	0	3
15	16NOEX15	Industrial Automation Systems	OE	50	50	100	3	0	0	3
16	16NOEX16	Measurements and Instrumentation	OE	50	50	100	3	0	0	3
17	16SOEX17	Enterprise JAVA	OE	50	50	100	3	0	0	3
18	16SOEX18	Cyber Security	OE	50	50	100	3	0	0	3
19	16SOEX19	Network Essentials	OE	50	50	100	3	0	0	3
20	16IOEX20	Programming in Python	OE	50	50	100	3	0	0	3
21	16IOEX21	BIG Data Science	OE	50	50	100	3	0	0	3
22	16IOEX22	Object Oriented Programming using C++	OE	50	50	100	3	0	0	3
23	16BOEX23	Computational Biology	OE	50	50	100	3	0	0	3
24	16BOEX24	Biology for Engineers	OE	50	50	100	3	0	0	3
25	16BOEX25	Fundamentals of BioEngineering	OE	50	50	100	3	0	0	3

ONE CREDIT COURSES

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End sem Marks	Total Marks	Credits			
							L	T	P	C
1	16MOC1Z1	Human Values-I	OC	100	-	100	1	0	0	1
2	16MOCX02	Human Values and Professional Ethics	OC	100	-	100	1	0	0	1
3	16MOCX03	Yoga for Youth Empowerment	OC	100	-	100	1	0	0	1
4	16MOCX04	Basics of Civil Engineering	OC	100	-	100	1	0	0	1
5	16MOCX05	Metallography	OC	100	-	100	1	0	0	1
6	16MOCX06	Design of Experiments using Taguchi Techniques	OC	100	-	100	1	0	0	1
7	16MOCX07	Micromachining	OC	100	-	100	1	0	0	1
8	16MOCX08	Wind Energy Management	OC	100	-	100	1	0	0	1
9	16MOCX09	Solar Energy Management	OC	100	-	100	1	0	0	1
10	16MOCX10	Project Management	OC	100	-	100	1	0	0	1
11	16MOCX11	Personality Development	OC	100	-	100	1	0	0	1
12	16MOCX12	Six Sigma	OC	100	-	100	1	0	0	1
13	16MOCX13	Bio fuels Technology	OC	100	-	100	1	0	0	1
14	16MOCX14	Professional Skills	OC	100	-	100	1	0	0	1

CBCS

MECHANICAL ENGINEERING (UG) CURRICULUM DESIGN

CREDIT SUMMARY

Name of the UG Programme: B.E - MECHANICAL ENGINEERING

Sl. No	Subject Area	Credits per Semester								Credits Total	% of Total Credits	Total no of subjects	AICTE Recommended Range of Credits %	
		I	II	III	IV	V	VI	VII	VIII				MIN	MAX
1	**HS**	3	6					3		12	7	4	5	10
2	**BS**	12	9	4	4					29	16	9	15	20
3	**ES**	7	11	10	3					31	17	11	15	20
4	**PC**			9	16	20	17	3		65	35	23	30	40
5	**PE**						3	9	6	18	10	6	10	15
6	**OE**					3	3	3		9	5	3	5	10
7	**EEC**					2	4	4	8	18	10	5	10	15
	Total	**22**	**26**	**23**	**23**	**25**	**27**	**22**	**14**	**182**	**100**			

16MHS1Z1 **COMMUNICATION SKILLS IN ENGLISH** **Category : HS**

Common to all branches

L	T	P	C
2	2	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To make the learners understand the usage of basic grammar in English.*
- *To enhance the learner's speaking skills through appropriate listening practice.*
- *To instill reading habits to practice communicative tasks and comprehension*
- *To improve the learner's writing skills through various means*
- *To enrich the vocabulary of learners for speaking and writing*

UNIT - I **6+6 Periods**

Listening - Listening to practice basic pronunciation at phonemic and word level, Listening to informal conversations of exchanging greetings and introducing oneself/others; **Speaking**- Introducing oneself, one's family / friend, speaking about one's place; **Reading**-Reading to practice stress and pause; **Writing**-Autobiographical writing, Letter to seek permission, Letter to issue certificates; **Grammar**- Use of Auxiliary Verbs, Adjectives and Adverbs; **Vocabulary**-Word formation, Synonyms and Antonyms of High frequency words.

UNIT – II **6+6 Periods**

Listening-Listening to Telephone Conversations for taking and leaving messages, making enquiries; **Speaking -** Role-play activities based on real life situations, Narrating daily routines; **Reading -** skimming and scanning, Reading for comprehension with exercises; **Writing**-Advertisements and slogan writing, Imperative instructions, Definitions; **Grammar** – Tenses, Prepositions; **Vocabulary**-Commonly confused words.

UNIT - III **6+6 Periods**

Listening -Listening to give instructions, Making requests and responding to requests, Thanking someone and responding to thanks; **Speaking** -Group Discussion on chosen topics, Describing a simple process; **Reading**-Reading and interpreting visual material, Critical reading; **Writing** –Letter to the Editor of a Newspaper, Recommendations; **Grammar**- Impersonal Passive, Subject-verb agreement; **Vocabulary**-Collocation, Word Association .

UNIT - IV **6+6 Periods**

Listening-Listening to accept/refuse invitation, Listening to apologize, Listening to congratulate; **Speaking** – Debates on current social affairs; **Reading** –Reading to make inference, Paraphrasing; **Writing-** Personal letter (Inviting your friend to a function, congratulating someone on his / her success, thanking one's friends / relatives); **Grammar** – 'Wh'-questions, Modal verbs; **Vocabulary** -Single word substitutes -Use of abbreviations & acronyms.

UNIT - V **6+6 Periods**

Listening -Video Listening to different accents, Viewing Speeches, Viewing English songs, Viewing short films; **Speaking** -Giving impromptu talks, Making presentations on given topics; **Reading** –Extensive reading; **Writing** –Writing General Article, Writing Short Stories; **Grammar** - Common Errors in English; **Vocabulary** –Word Pairs with Repetitive meaning.

LECTURE: 30 PERIODS TUTORIAL: 30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 60 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Department of English, Anna University. Mindscapes	*English for Technologists and Engineers*	*Orient Blackswan, Chennai. 2012*
Sadanand, Kamlesh & Punitha, Susheela	*Spoken English: A Foundation Course (Part 1)*	*Orient Blackswan, Hyderabad. 2014*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Raman, Meenakshi & Sangeetha Sharma	*Technical Communication: Principles and Practice*	*Oxford University Press, New Delhi. 2011*
Vijay, Anbazhagan.J, & Jaishree.N	*Technical English-I*	*Global Publishers, Chennai, 2016*
Rizvi, Ashraf. M.	*Effective Technical Communication*	*Tata McGraw-Hill, New Delhi. 2005*
Rutherford, Andrea. J Basic	*Communication Skills for Technology*	*Pearson, New Delhi. 2001*
Redston, Chris, Cunningham, Gillie	*Face 2 Face: Elementary Student's Book*	*Cambridge University Press, New Delhi. 2009*

EXTENSIVE READING

(Not for Examination)

Kalam, Abdul.A.P.J Wings of Fire. Universities Press, Hyderabad. 1999.

WEBSITES

1. http://www.usingenglish.com
2. http://www.uefap.com

COURSE OUTCOMES:

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

CO1: *The learner will be able to understand basic grammar and the learner will have sufficient command over language by training his tongue and tuning his ear through apt listening tasks.*

CO2: *Reading tasks will enable the learner practice phonological and linguistic aspect of learning, help comprehend and create interest in extensive reading.*

CO3: *The learner shall be able to write appropriately for a given context and use the right word at the right place.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1			M		M									M	
CO 2						M					M				M
CO 3										H					
16MHS1Z1			L		L	L				L	L			L	L

L-Low, M-Moderate(Medium), H-High

16MBS1Z2 **ENGINEERING MATHEMATICS I** **Category : BS**

Common to all branches

L	T	P	C
3	2	0	4

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To familiarize techniques of matrix algebra including properties of eigen values and eigen vectors.*
- *To gain the knowledge of hyperbolic functions and application problems in differential calculus.*
- *To familiarize with functions of several variables and Functions of two variables including extremum problems, Jacobian and Leibnitz rule of integration.*
- *To perform double and triple integration with relevant to surface area and volume of solid.*

UNIT - I MATRICES **9+6 Periods**

Eigen values and Eigen vectors of a real matrix-Characteristic equation-Properties of Eigen values and eigen vectors-Cayley Hamilton theorem - Diagonalization of matrices-Reduction of a quadratic form to canonical form by orthogonal transformation-Nature of quadratic forms.

UNIT - II HYPERBOLIC FUNCTIONS AND DIFFERENTIAL CALCULUS **9+6 Periods**

Hyperbolic and Inverse Hyperbolic functions-Identities- Real and Imaginary parts-Solving Problems using Hyperbolic functions.

Curvature and radius of curvature-Cartesian and polar coordinates- center of curvature and Evolutes-Envelopes and Evolute as envelope of normal.

UNIT - III FUNCTIONS OF SEVERAL VARIABLES **9+6 Periods**

Functions of two variables- Taylor's theorem (statement only) and expansions-Maxima and Minima-Constrained extremum by Lagrange's multiplier method-Jacobians-Differentiation under integral sign

UNIT - IV INTEGRAL CALCULUS **9+6 Periods**

Definite and Indefinite integrals-Substitution rule-Techniques of Integration-Integration by parts-Trigonometric substitutions-Integration of rational function by partial fractions-Integration of irrational functions-Improper integrals.

UNIT - V MULTIPLE INTEGRALS **9+6 Periods**

Beta and Gamma integrals and properties. Double Integrals-Change of order of integration-Double integrals in polar coordinates-Area enclosed by plane curves-Triple integrals-Volume as a triple integral-Transformation to Polar, Cylindrical and Spherical polar coordinates.

LECTURE: 45 PERIODS TUTORIAL: 30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 75 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Veerarajan T	*Engineering Mathematics for Semesters I and II*	*Tata McGraw Hill Publishing Co., New Delhi, 2015.*
Kandasamy P, Thilagavathy K and Gunavathy K	*Engineering Mathematics for I year B.E/B.Tech.*	*S.Chand & Co, Ramnagar, New Delhi, Reprint2013.*
S. Narayanan and Manicavachagom Pillai T.K	*Calculus, Vol.I , II and III,*	*S. Viswanathan, Printers and Publishers Pvt. Ltd, Chennai, 2009.*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Erwin Kreyszig	*Advanced Engineering Mathematics*	*Wiley & sons (Asia) Ltd, 10th Edition, 2015.*
Ray Wylie.C and Louis Barrett	*Advanced Engineering Mathematics*	*Tata McGraw Hill Company, New Delhi, 2004.*
Grewal B. S	*Higher Engineering Mathematics*	*Khanna Publishers, New Delhi, 43rd Edition, 2014.*
Ramana B V	*Higher Engineering Mathematics*	*Tata McGraw Hill Co. Ltd, NewDelhi, 11th Print, 2010.*
Bali N., Goyal M and Watkins C	*Advanced Engineering Mathematics*	*Firewall Media (An Imprint of Laxmi Publications Pvt Ltd), New Delhi, 7th Edition, 2009.*
Bali N.P and Goyal M	*A text book of Engineering Mathematics*	*University Science Press (An Imprint of Laxmi Publications Pvt Ltd), New Delhi,2014*

COURSE OUTCOMES:

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

CO1: *Acquire knowledge of eigen values and eigen vectors including properties through matrix theory.*

CO2*: Understand the hyperbolic functions and applications of differential calculus.*

CO3*: Acquire fluency in partial differentiation and solving problems related to maxima and minima for more independent variables.*

CO4*: Understand the standard types of integration and solution to various integrals.*

CO5: *Understand the multiple integrals and their applications to engineering problems.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	H	H	H	M						H	M	M	M	H	
CO 2	H	M	M							M			M	H	L
CO 3	H	H	H							L			M	M	L
CO 4	H	H	M	M						M	L	M		M	
CO 5	H	M	M							L	L	M		H	L
16MBS1Z2	H	H	H	M						M	L	M	M	H	L

L-Low, M-Moderate(Medium), H-High

16MBS103	APPLIED PHYSICS	Category: BS
	Common to Civil, Mechanical, Production and Industrial Biotechnology branches	L T P C 3 0 0 3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology. Upon completion of this course the students will be familiar with:

- *Concepts, types of lasers and its applications, fibre optic principles and its applications.*
- *Basics of properties of matter & thermal physics*
- *Origin of quantum physics, Schrödinger's equation and applications.*
- *Principles of acoustics, ultrasonics and their industrial applications.*
- *Fundamentals of vacuum science, production and measurement.*

UNIT - I LASERS & FIBRE OPTICS 9 Periods

Introduction- Principle of laser action - characteristics of laser - Spontaneous emission and Stimulated emission –Einstein's coefficients - population inversion – methods of achieving population inversion –Optical Resonator -Types of Lasers – Principle, construction and working of Nd-YAG, CO_2, Semiconductor laser - applications of laser-Hologram.

Introduction – Basic Principles involved in fiber optics- Total internal reflection – Structure of optical fiber –Propagation of light through optical fiber –Derivation for Numerical Aperture and acceptance angle - fractional index change - Classification of optical fiber based on materials, refractive index profile and Modes - Fiber optical communication links-Fiber optic sensors- displacement

UNIT - II PROPERTIES OF MATTER & THERMAL PHYSICS 9 Periods

Elasticity- Hooke's law- stress-strain diagram - Factors affecting elasticity - Bending moment - Depression of a cantilever - Young's modulus by uniform bending - I shaped girders.

Thermal expansion - thermal stress - thermal conductivity - heat conduction in solids - flow of heat through compound media - Forbe's and Lee's disc method: theory and experiment.

UNIT - III QUANTUM PHYSICS AND APPLICATIONS 9 Periods

Limitations of classical Physics - Introduction to Quantum theory - Dual nature of matter and radiation- de-Broglie wavelength in terms of voltage, energy, and temperature –Heisenberg's Uncertainty principle – verification – physical significance of a wave function- Schrödinger's Time independent and Time dependent wave equations –- Particle in a one dimensional potential well - Scanning Electron Microscope (SEM)-Transmission Electron Microscope (TEM).

UNIT - IV ACOUSTICS & ULTRASONICS 9 Periods

Classification of sound - loudness and intensity - Weber-Fechner law - standard intensity and intensity level - decibel - reverberation - reverberation time - sound absorbing materials - Determination of absorption coefficient - factors affecting acoustics of buildings.

Introduction - properties of ultrasonic waves - production of ultrasonic waves; Magnetostriction effect- Magnetostriction generator- Piezoelectric effect- Piezoelectric generator- Acoustic grating - Determination of wavelength and velocity of ultrasonics - cavitation - applications- ultrasonic drilling- ultrasonic welding- ultrasonic soldering and ultrasonic cleaning-Non- destructive Testing- Pulse echo system

UNIT - V VACUUM SCIENCE 9 Periods

Introduction - Importance of vacuum in industries - Pumping speed and throughput - Types of pumps-Rotary vane type Vacuum pump(oil sealed), Diffusion Pump and Turbo Molecular Pump - Measurement of High Vacuum-McLeod Gauge-Pirani Gauge-Penning Gauge - Application to thin film technology.

LECTURE: 45 PERIODS TUTORIAL: 0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Arumugam M	*Engineering Physics*	*Anuradha Publishers, 2010. (Unit I & Unit III)*
P.K.Palanisamy	*Engineering physics-I*	*SciTech Publications (India) Pvt. Ltd,2015. (Unit II & Unit IV)*
Ganesan S and Iyandurai N	*Applied Physics*	*KKS Publishers, Chennai, 2007.(Unit V)*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Avadhanulu M N and Kshirsagar P G	*A Textbook of Engineering Physics*	*S.Chand and Company Ltd, New Delhi, 2010.*
Gaur R.K. and Gupta S.L	*Engineering Physics*	*Dhanpat Rai Publishers, 2009.*
K.Rajagopal	*Engineering Physics*	*PHI Learning Private limited, New Delhi,2015.*

COURSE OUTCOMES:

Upon completion of the course the students will be able to

CO1: *Analyze the construction and working of Nd-YAG, CO2, Semiconductor lasers. Explain fiber optics and classify fibers based on index profiles and modes. [Familiarity]*

CO2: *Acquire knowledge in properties of matter and thermal Physics [Application]*

CO3: *Analyze the dual nature of matter using Heisenberg's Uncertainty principle, Schrodinger's time independent and dependent wave equations. [Assessment]*

CO4: *Apply piezoelectric detector method for industrial applications. [Usage and Assessment]*

CO5: *Production & Measurement of vacuum. [Familiarity]*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	M	M	M	M	M	M	M						M	M	M
CO 2	H	H	H	H	H	H	H						H	H	H
CO 3	M	M			M	M	M						M	M	M
CO 4	H	H	H	H	H	H	H						H	H	H
CO 5	H	H	H	H	H	H	H						H	H	M
16MBS103	H	H	M	M	H	H	H						H	H	M

L-Low, M-Moderate(Medium), H-High

16MBS104 **ENGINEERING CHEMISTRY** **Category : BS**

Common to Civil, Mechanical and Production

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *The course is aimed at imparting knowledge of Engineering Chemistry topics which would be useful for students to understand chemistry relevant to conventional engineering fields.*

UNIT - I **WATER TECHNOLOGY** **9 Periods**

Water - sources - types of impurities, hardness - temporary and permanent – units - ppm and mg/L - estimation of hardness – EDTA method- problems - Boiler troubles - internal treatment – external treatment - lime soda process and ion exchange process - Drinking water – characteristics - colour, odour, turbidity, chloride - treatment - preliminary, primary and disinfection methods - chlorination- breakpoint chlorination, desalination – reverse osmosis.

UNIT - II **POLYMER TECHNOLOGY** **9 Periods**

Polymers - definitions of monomer, polymer, functionality, degree of polymerisation – Free radical mechanism -Individual polymers - PVC, PMMA, Teflon, polyamide, poly carbonate, epoxy, polyurethane - preparation, properties and their end users - compounding of plastics - components and functions - fabrication techniques - compression, injection, extrusion and blow moulding - Conducting polymers - structures of polypyrrole, polyaniline and poly acetylene - conduction mechanism of polyacetylene only - Biodegradable polymers – polylactide, starch and cellulose.

UNIT - III **FUELS AND COMBUSTION** **9 Periods**

Fuels - classifications - calorific value - Gross and Net-Determination by Dulong's formula - problems - combustion – theoretical air-principle and calculations - solid fuels – Coal - proximate and ultimate analysis - significance- Coke- characteristics - manufacture by Otto Hoffman method - Liquid fuels – petroleum - fractionation - petrol and diesel - knocking of IC engines and diesel engines - octane and cetane number - anti-knocking agents – Biogas – biodiesel.

UNIT - IV **ENGINEERING MATERIALS** **9 Periods**

Refractories – classification - properties and manufacture of silica and magnesia bricks; Abrasives- Classification-properties - manufacture of SiC -; Lubricants –solid lubricants (Graphite & Molybdenum sulphide) hydrodynamic mechanism of lubrication – Cement – manufacture - setting and hardening of cement - special cements - Alumina cement, waterproof cement, high early strength cement.

UNIT - V **CORROSION** **9 Periods**

Corrosion - Spontaneity - Chemical corrosion- mechanism, nature of oxides – Pilling Bedworth rule - electrochemical corrosion – mechanism - types – galvanic and differential aeration – Galvanic series and importance – Prevention methods - design of materials, cathodic protection techniques (sacrificial anode and impressed current cathode), Inhibitors - Protective coatings - Inorganic coating - electroplating – surface preparation and plating method applied to Cr and Ni and galvanising – Organic coating- paints - constituents and functions.

LECTURE: 45 PERIODS **TUTORIAL: 0 PERIODS** **PRACTICAL: 0 PERIODS** **TOTAL: 45 PERIODS**

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Vairam S, Subha Ramesh	*Engineering Chemistry*	*Wiley India, 2015*
Jain. P.C. and Monica Jain	*Engineering Chemistry*	*Dhanpat Rai publications Pvt. Ltd, New Delhi, 16th Edition, 2015.*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Dara. S.S, Umare	*Text book of Engineering Chemistry*	*S. Chand Publications, 2004.*
Agarwal C.V.	*Chemistry of Engineering Materials*	*9th Edition, B.S. Publications, 2006.*
Kuriakose, J.C., and Rajaram J	*Chemistry in Engineering and Technology", Vol.1 & II,*	*Tata Mc Graw Hill Publishing company Pvt.Ltd, New Delhi, 2001.*
O.P. Aggarwal, Avinash Aggarwal	*Engineering Chemistry*	*Khanna Publishers, 2010.*
Sivasankar B	*Engineering Chemistry*	*Tata McGraw Hill Publications, 2008.*

COURSE OUTCOMES:

Upon completion of the course the students will be able to

CO1*: Understand the nature of impurities and the effects of various sources of water, and apply them in treatment them usable for industrial and domestic purposes.*

CO2*: Know about the different types of polymeric materials, properties and fabrication which match the specific applications.*

CO3*: Learn the different types of fuels with their compositions, combustion characteristics in engines and apply them in design of combustion chambers.*

CO4*: Be familiar with the various engineering materials, refractories, abrasives, lubricants and cements with their properties and manufacturing methods which are used in engineering applications.*

CO5*: Gain the knowledge about corrosion of the machinery they use in their fields and, also to understand the mechanisms and to adopt the preventive measures by various techniques.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	H	L	H	L	L	M	M	H	L	L	L	L	H	M	M
CO 2	M	L	H	L	L	M	L	H	L	M	M	L	M	M	M
CO 3	H	M	H	L	L	M	H	H	M	L	M	M	H	H	H
CO 4	H	M	M	M	L	L	L	L	M	L	M	L	M	M	M
CO 5	H	M	H	L	L	H	M	M	M	L	M	L	H	M	M
16MBS104	H	M	H	L	L	M	M	M	M	L	M	L	H	M	M

L-Low, M-Moderate(Medium), H-High

16MES105 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING Category : ES

Common to Mechanical, Production and	L	T	P	C
Industrial Biotechnology branches	3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To study the basic concepts of electric circuits, electronic devices and communication engineering.*
- *To know the fundamental of energy conversion, construction, principle of operation, characterization of DC machines and AC machines.*

UNIT - I ELECTRICAL CIRCUITS & MEASUREMENTS 9 Periods

Ohm's Law – Kirchoff's Laws – Steady State Solution of DC circuits – Introduction to AC Circuits – Waveforms and RMS Value – Power and Power factor – Single Phase and Three Phase Balanced Circuits.

Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

UNIT - II ELECTRICAL MACHINES 9 Periods

Construction, Principle of Operation, Basic Equations and Types, Characteristics and Applications of DC Generators, DC Motors, Single Phase Transformer, Single Phase induction motor.

UNIT - III SEMICONDUCTOR DEVICES AND APPLICATIONS 9 Periods

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers - Voltage Regulation.

Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Working principle and Characteristics of FET, JFET, MOSFET – Characteristics and Simple Application of SCR, DAC, TRIAC & UJT – Elementary Treatment of Small Signal Amplifier.

UNIT - IV DIGITAL ELECTRONICS 9 Periods

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders - Flip-Flops – Registers and Counters – A/D and D/A Conversion (Simple concepts).

UNIT - V FUNDAMENTALS OF COMMUNICATION ENGINEERING 9 Periods

Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations.

Communication Systems: Radio, TV, Microwave, Satellite, RADAR and Optical Fibre (Block Diagram Approach only).

LECTURE: 45 PERIODS TUTORIAL: 0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Muthusubramanian R, Salivahanan S and Muraleedharan K A	*Basic Electrical and Electronics Engineering*	*Tata McGraw Hill, Second Edition, (2009).*
Mittle.V.N and Arvind Mittal	*Basic Electrical Engineering*	*Tata McGraw Hill, Second Edition, New Delhi, 2005.*
Sedha R.S	*A Text book of Applied Electronics*	*S. Chand & Co., 2008.*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Nagsarkar T K and Sukhija M S	*Basics of Electrical Engineering*	*Oxford Press (2005).*
Mehtra V.K and Rohit Mehta	*Priniciples of Electrical Engineering and Electronics*	*S. Chand & Co. 2nd Edition 2015.*
Mahmood Nahvi and Joseph A. Edminister	*Electric Circuits, Schaum' Outline Series*	*McGraw Hill, Sixth edition (2014)*
Premkumar N and Gnanavadivel J	*Basic Electrical and Electronics Engineering*	*Anuradha Publishers, 4th Edition (2008).*

COURSE OUTCOMES:

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

CO1: *Analyze simple DC and AC Circuits.*

CO2: *Understand the significance of Electrical machines.*

CO3: *Apply knowledge on semiconductor devices and Integrated circuits.*

CO4: *Understand the concepts of communication engineering.*

CO5: *Design simple circuits using electronic components for specific applications.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	H	H				M	M				L	M	L		
CO 2	H	M	M				M				L			L	
CO 3	H	L	L		M		L							M	
CO 4	H		L		M		L				L	L			L
CO 5	H	M	H	M	M	L					L	M		H	
16MES105	H	M	M	L	M	M	M				L	M	L	L	L

L-Low, M-Moderate(Medium), H-High

16MBS106	PHYSICS LABORATORY	Category : BS
	Common to Civil, Mechanical, Production and Industrial Biotechnology branches	L T P C 0 0 4 2

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To have a practical knowledge about the concepts behind physics and the need to apply in the emerging technology.*

LIST OF EXPERIMENTS

1. Spectrometer - Diffraction Grating Normal Incidence Method
2. Air Wedge –Determination of thickness of a paper
3. Young's Modulus – Cantilever Bending - Koenig's Method
4. a. Laser - Particle size Determination
   b. Optical fiber - Determination of NA & Acceptance angle
5. Ammeter and Voltmeter Calibration – Low Range
6. Resistance Of The Given Coil Of Wire – Carey Foster's Bridge
7. Determination of Band gap Energy of Semiconductor
8. Ultrasonic Interferometer - Velocity of sound & Compressibility of liquids.
9. Transistor Characteristics
10. Torsional pendulum –Determination of Rigidity Modulus & Moment of Inertia

LECTURE: 0 PERIODS TUTORIAL: 0 PERIODS PRACTICAL: 60 PERIODS TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of this practical classes, the students will be able to

CO1: *Determinate all physical properties of any matter, basic idea of calibrating electrical measuring instruments and thereby effectively using it for particular applications.*

CO2: *Experiment intrinsic characteristic features of electronic devices for electrical and electronic applications.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	M	M	M	M	M	M	M						H	H	H
CO 2	M	M	M	M	M	M	M						L	L	L
16MBS106	M	M	M	M	M	M	M						M	M	M

L-Low, M-Moderate(Medium), H-High

16MES107	ENGINEERING GRAPHICS	Category : ES
	Common to Civil, Mechanical, Production and Industrial Biotechnology branches	L T P C 2 0 4 4

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *Geometrical constructions*
- *Orthographic projections.*
- *Performing section of solids and development of the same.*
- *Interpretation of solids.*
- *Pictorial view of solids*

UNIT - I GEOMETRICAL CONSTRUCTIONS 15 Periods

Dimensioning-Lettering-Types of Lines-Scaling conventions-Dividing a given straight line in to any number of equal parts- Bisecting a given angle- Drawing a regular polygon given one side-Special methods of constructing a pentagon and hexagon- Construction of curves like ellipse, parabola, cycloid and involute using one method.

UNIT - II ORTHOGRAPHIC PROJECTIONS 25 Periods

Introduction to Orthographic Projection-Projection of points-Projection of straight lines with traces-Projection of planes-Conversion of pictorial views to orthographic views-Projection of solids - Auxiliary projections.

UNIT - III SECTION OF SOLIDS AND DEVELOPMENT 20 Periods

Section of solids- Development of surfaces.

UNIT - IV INTERPENETRATION OF SOLIDS AND PICTORIAL VIEWS 20 Periods

Cylinder and cylinder, cone and cylinder only Isometric projections - Conversion of orthographic views to pictorial views (simple objects).

UNIT - V INTRODUCTION TO AUTOCAD 10 Periods

Object Construction: Page layout – Layers and Line types – Creating, Editing and selecting the Geometric Objects. Viewing, Annotating, Hatching and Dimensioning the drawing –Creating Blocks and Attributes.

LECTURE: 30 PERIODS TUTORIAL: 0 PERIODS PRACTICAL: 60 PERIODS TOTAL: 90 PERIODS

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
K.Vengopal	*Engineering Graphics*	*New Age International (P) Limited, 2015.*
Dhananjay.A.Jolhe	*Engineering Drawing*	*Tata McGraw Hill Publishing Co., 2007.*
K.V.Nataraajan	*A text book of Engineering Graphics*	*Dhanalakshmi Publishers, Chennai, 2006.*
M.B.Shah and B.C. Rana	*Engineering Drawing*	*Pearson Education, 2005.*
Luzadder and Duff	*Fundamentals of Engineering Drawing*	*Prentice Hall of India Pvt Ltd, XI Edition, 2001.*
K.L.Narayana and P.Kannaiah	*Text book on Engineering Drawing*	*2nd Ed., Scitech Publications (India) Pvt. Ltd, Chennai, 2009.*

COURSE OUTCOMES:

Upon completion of the course the students will be able to

CO1: *Represent planes and solids as per international standards.*

CO2: *Generate and interpret multiple views through development, interpretation and sectional views.*

CO3: *Generate and interrupt orthographic views.*

CO4: *Generate and interrupt pictorial views and interpenetration.*

CO5: *Generate and interrupt perspective views.*

CO6: *Apply the concept of AUTO CAD in engineering graphics.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1		H	H			M		L	H	M		M	M	M	
CO 2			H			M		L	H	M		M	M	M	
CO 3			H			M		L	H	M		M	M	M	
CO 4			H			M		L	H	M		M	M	M	
CO 5			H			M		L	H	M		M	M	M	
CO 6		H	H	H		M		L	H	M		M	M	M	
16MES107		L	H	L		M		L	H	M		M	M	M	

L-Low, M-Moderate(Medium), H-High

16MHS2Z1 **TECHNICAL ENGLISH** **Category : HS**

Common to all branches

L	T	P	C
2	2	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To make learners acquire guided listening and speaking skills in both formal and informal contexts.*
- *To help them develop reading skills by familiarizing them with different types of reading tasks and strategies*
- *To make them understand advance level of grammar and equip them with writing skills needed for academic as well as workplace contexts.*
- *To explore the learner to Technical English and Technical Vocabulary.*

UNIT - I **6+6 Periods**

Listening - Listening to ask for/ give opinions, Listening to persuade/dissuade people, Listening to make complaints, Listening to transfer information; **Speaking** –Role play activities on a formal/corporate context, Delivering Welcome Address- **Reading** – Reading to infer lexical and contextual meaning; **Writing** - Effective use of SMS on Whatsapp/ Hike/ Messenger, Writing E-mails on a business context, Technical style; **Grammar** – Use of relative / reflexive pronouns, Discourse Markers; **Vocabulary**- Homonyms and Homophones

UNIT - II **6+6 Periods**

Listening - Listening to express regrets/sympathy/condolences, Listening and Note-taking; **Speaking** – Addressing at an official meeting to deal with problems/ sensitive issues, Discussion on a movie with a poignant social message/ or on a recently read book; **Reading** - Reading a short story or an article from newspaper; **Writing** - Writing a review of a book/movie/music concert/sports event, Graph Description; **Grammar** – Noun/Adjective/Adverbial phrases, Cause and effect expressions; **Vocabulary** - Using phrasal verbs in sentences, Jargon

UNIT - III **6+6 Periods**

Listening - Listening to a talk about using quantities, Listening to describe manner and frequency, Listening to expressions of assumptions/inference, Listening to make comparisons; **Speaking** –Making conversation to practice stress, pause, pronunciation and intonation, Introducing the chief-guest; **Reading** - Speed reading – reading passages with time limit - **Writing** – Notice, Agenda and Minutes of meetings; - Elements of Writing Technical articles –**Grammar** - Numerical expressions, Conditional clauses; **Vocabulary** - Same word used as different parts of speech, Register

UNIT - IV **6+6 Periods**

Listening - Listening to talks about future events/plans, Listening to a talk about making arrangements, Listening to language of reporting, Viewing a model discussion; **Speaking** – Discussion on a formal/corporate context, Proposing vote of thanks; **Reading** - Reading the job advertisements and the profile of the company concerned; **Writing** - Process Description, Applying for a job with résumé; **Grammar** - Direct and indirect speech; **Vocabulary** - Idioms

UNIT - V **6+6 Periods**

Listening – Listening to expressions of possibility, Listening to expressions of obligations, Listening to expressions of ability, Viewing model interviews; **Speaking** - Mock interview; **Reading** - Note making, Intensive reading; **Writing** – Checklist, - Feasibility / Project report; **Grammar** – Time Statements and Contracted Time Statements; **Vocabulary** – Nominal Compounds

LECTURE: 30 PERIODS TUTORIAL: 30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 60 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Department of English, Anna University. Mindscapes	*English for Technologists and Engineers.*	*Orient Blackswan, Chennai. 2012*
Sadanand, Kamlesh & Punitha, Susheela	*Spoken English: A Foundation Course (Part 2).*	*Orient Blackswan, Hyderabad. 2014*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Raman, Meenakshi & Sangeetha Sharma	*Technical Communication: Principles and Practice*	*Oxford University Press, New Delhi. 2011*
Vijay, Anbazhagan.J, & Jaishree.N	*Technical English-II*	*Global Publishers, Chennai, 2016*
Rizvi, Ashraf. M.	*Effective Technical Communication*	*Tata McGraw-Hill, New Delhi. 2005*
Herbert, A.J	*Structure of Technical English*	*The English Language Society, London. 1971*
Michigan,E.A	*Word Power and Speed Reading: English Improvement Series*	*Infinity Books, New Delhi, 2007*
Rajendrapal & Korlahalli. J.S	*Essentials of Business Communication*	*Sultan Chand & Sons*

WEBSITES

1. http://www.usingenglish.com
2. http://www.uefap.com

COURSE OUTCOMES:

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

CO1: *The learners will be able to speak convincingly at work place and social contexts through guided listening tasks and different genres and strategies of reading.*

CO2: *The learner will understand advance level of grammar and write professionally to a larger extent for workplace and general contexts.*

CO3: *The learners will familiarize themselves with Technical Vocabulary and Technical English.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1			L		L	M					M				
CO 2										H				M	M
CO 3															
16MHS2Z1			L		L	L				L	L			L	L

L-Low, M-Moderate(Medium), H-High

16MBS2Z2 **ENGINEERING MATHEMATICS II** **Category : BS**

Common to all branches

L	T	P	C
3	2	0	4

PRE-REQUISITES: *Basics of - trigonometry- differential and integral formulae.*

COURSE OBJECTIVES:

- *To acquire knowledge of techniques of ordinary differential equations leading to engineering problems.*
- *To acquire knowledge of vector Calculus with engineering applications.*
- *To gain standard techniques of complex variable applicable to fluid dynamics, heat conduction, and elasticity.*
- *To develop skill of solving transforms leading to engineering applications.*

UNIT - I **ORDINARY DIFFERENTIAL EQUATIONS** **9+6 Periods**

Second and Higher order Differential Equations, Method of variation of parameters- Method of undetermined coefficients-Homogeneous equations of Euler's and Legendre's type-System of Simultaneous first order Linear equations with constant coefficients - Method of reduction of order.

UNIT - II **VECTOR CALCULUS** **9+6 Periods**

Gradient and directional derivative, Divergence and Curl – Irrotational and Solenoidal fields- Vector identities - Line, Surface and Volume Integrals – Green's Theorem in a Plane , Gauss Divergence and Stoke's Theorems (Statements only) –Verifications and Applications.

UNIT - III **COMPLEX DIFFERENTIATION** **9+6 Periods**

Functions of a Complex variable-Analytic functions- Cauchy Riemann equations and sufficient conditions (excluding proof)–Harmonic conjugates–Construction of analytic functions-Conformal mappings: $w=z+a$, az, $1/z$, z^2, e^z , sinz, cosz and Bilinear Transformation.

UNIT - IV **COMPLEX INTEGRATION** **9+6 Periods**

Cauchy's integral theorem, Cauchy's integral formula -Taylor's and Laurent's theorems (Statements only) and expansions – Poles and Residues – Cauchy's Residue theorem – Contour integration – Circular and semi circular contours with no pole on real axis.

UNIT - V **LAPLACE TRANSFORMATIONS** **9+6 Periods**

Laplace transforms- Properties and standard transforms-Transforms of unit step, unit Impulse and error functions –Transforms of periodic functions- Inverse Laplace transforms- Initial and Final value theorems- Convolution theorem (Statement only) and applications - Applications to Solution of Linear differential equations of second order with constant coefficients.

LECTURE: 45 PERIODS TUTORIAL: 30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 75 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Veerarajan T	*Engineering Mathematics" for Semesters I and II*	*Tata McGraw Hill Publishing Co., New Delhi, 2015.*
Kandasamy P, Thilagavathy K and Gunavathy K	*Engineering Mathematics" for I year B.E/B.Tech*	*S.Chand & Co, Ramnagar, New Delhi,Reprint2013.*
S. Narayanan and Manicavachagom Pillai T.K.	*Calculus-Vol.III*	*S. Viswanathan, Printers and Publishers Pvt. Ltd, Chennai, 2009.*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Erwin Kreyszig	*Advanced Engineering Mathematics*	*Wiley & sons (Asia) Ltd, 10th Edition, 2015.*
Ray Wylie.C and Louis Barrett	*Advanced Engineering Mathematics*	*Tata McGraw Hill Company, New Delhi, 2004.*
Grewal B. S	*Higher Engineering Mathematics*	*Khanna Publishers, New Delhi, 43rd Edition, 2014.*
Ramana B V	*Higher Engineering Mathematics*	*Tata McGraw Hill Co. Ltd, NewDelhi, 11th Print, 2010.*
Bali N., Goyal M and Watkins C	*Advanced Engineering Mathematics*	*Firewall Media (An Imprint of Laxmi Publications Pvt Ltd), New Delhi, 7th Edition, 2009.*
Bali N.P and Goyal M	*A text book of Engineering Mathematics*	*University Science Press (An Imprint of Laxmi Publications Pvt Ltd), New Delhi, 2014.*

COURSE OUTCOMES:

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

CO1: *Understand the kinds of differential equations and their solutions in the field of engineering.*

CO2: *Evaluate gradient, divergence and curl and also line, surface and volume integrals in cartesian form and simple coordinate systems and calculate integrals applying Greens, stokes and Gauss theorems.*

CO3: *Understand the concepts of analytic functions and conformal mappings.*

CO4: *Evaluate contour integrals using calculus of residues.*

CO5: *Apply Laplace transform methods to solve differential equations.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H						M	H	H	M	H	M
CO 2	H	H	M	M						M		M	M	H	M
CO 3	H	H	M	H		M				M	M	M		L	L
CO 4	H	H	M	M		M				M	M	M		H	L
CO 5	H	H	H	H		H				M	M	H	M	H	M
16MBS2Z2	H	H	M	H		M				M	M	M	M	H	M

L-Low, M-Moderate(Medium), H-High

16MBS2Z3	MATERIALS SCIENCE	Category : BS
	Common to all branches	L T P C
		3 0 0 3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology. Upon completion of this course the students will be familiar with:

- *The properties of conducting materials.*
- *The application of magnetic and super conducting materials.*
- *Application and properties of dielectric and ferro electric materials.*
- *Applications and properties of Modern engineering materials.*
- *Nano materials and its properties.*

UNIT - I CONDUCTING MATERIALS 9 Periods

Introduction to Conductors – classical free electron theory of metals – Draw backs of classical theory – quantum theory - Electrical and Thermal conductivity of Metals – Derivation for Wiedeman – Franz law – Lorentz number — Fermi distribution function - effect of temperature – density of energy states – calculation of Fermi energy- carrier concentration in metals.

UNIT - II SEMICONDUCTING MATERIALS AND DEVICES 9 Periods

Introduction – Properties – elemental and compound semiconductors - Intrinsic and extrinsic semiconductors – properties - Carrier concentration in intrinsic Semiconductor - variation of Fermi level with temperature and carrier concentration - Electrical Conductivity – band gap determination - extrinsic semiconductors - Carrier concentration in P- type and N-type semiconductors – variation of Fermi level with temperature and impurity concentration – Hall effect- Determination of Hall Co-efficient in N type and P type Semiconductor - Applications.

UNIT - III MAGNETIC AND SUPER CONDUCTING MATERIALS 9 Periods

Introduction - Origin of magnetic moment - Bohr magneton - Dia, Para, and Ferro magnetic materials - Domain theory of ferromagnetism - Hysteresis - Hard and Soft magnetic materials. Ferrites - structure and applications. - Magneto optical recording and readout – Superconductivity - Types of superconductors - BCS theory of superconductivity (qualitative) - properties- High Tc superconductors, Applications of superconductors- SQUID, Cryotron, Magnetic levitation.

UNIT - IV DIELECTRICS AND FERROELECTRICS 9 Periods

Introduction to dielectric materials – Electric polarization and Dipole moment - Electrical susceptibility – dielectric constant – Various polarization mechanisms in dielectrics - electronic, ionic, orientational and space charge polarization– frequency and temperature dependence of polarization – internal field – Claussius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown – Applications of dielectric materials - Ferro electricity –Ferro electric materials -$BaTiO_3$ – Applications- Ferro electric energy converter.

UNIT - V MODERN ENGINEERING MATERIALS 9 Periods

Metallic glasses- preparation of metallic glasses - properties – applications of the metallic glasses - Shape Memory Alloys (SMA) - Characteristics, properties of NiTi alloy - applications of the Shape memory alloys - advantages and disadvantages of SMA - Nanomaterials-synthesis –chemical vapour deposition – Sol Gel – ball Milling – properties of nanoparticles and applications of nanoparticles – Carbon Nanotubes (CNT) – structure – properties – applications of CNTs.

LECTURE: 45 PERIODS TUTORIAL: 0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
P.K.Palanisamy	*Engineering Physics–II*	*Scitech Publications (India) Pvt. Ltd 2015 (Unit I, Unit III & Unit IV)*
Dr.Jayakumar .S	*Materials science*	*R.K.Publishers,2008.(Unit II & IV)*
Dr.V.Rajendran	*Material Science*	*Tata McGraw Hill Publications, NewDelhi, 2011.*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Charles P.Poole, Jr; Frank J.Owens	*Introduction to Nanotechnology*	*Wiley India, 2012.*
Gaur R.K. and Gupta S.L	*Engineering Physics*	*Dhanpat Rai Publishers, 2009.*
K.Rajagopal	*Engineering Physics*	*PHI Learning Private Ltd, New Delhi, 2015.*

COURSE OUTCOMES:

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

CO1: *Analyze the properties of conducting materials. [Familiarity]*

CO2: *List and analyze the properties of Semiconducting materials and Devices. [Familiarity]*

CO3: *Identify, analyze the properties and applications of magnetic & super conducting materials. [Familiarity]*

CO4: *List and analyze the properties of dielectric Ferro electric materials. [Familiarity & Application]*

CO5: *List the properties and applications of modern engineering materials. [Familiarity & Application]*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	M	M				M	M						**L**	L	**L**
CO 2	M	M	M	M	M	M	M						M	M	M
CO 3	M	M	M	M	M	M	M						M	M	M
CO 4	M	M	M	M	M	M	M						M	M	M
CO 5	H	H	H	H	H	H	H						H	H	H
16MBS2Z3	M	M	M	M	M	M	M						M	M	M

L-Low, M-Moderate(Medium), H-High

16MHS2Z4 ENVIRONMENTAL SCIENCE AND ENGINEERING **Category : HS**

Common to all branches

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *The course is aimed at creating awareness among students and also to inseminate the critical ideas of preserving environment.*

UNIT - I ENVIRONMENTAL RESOURCES **9 Periods**

Natural resources -Forest – benefits, over exploitation, deforestation & consequences – Water - unique features, hydrological cycle & over exploitation – Food -effect of modern agriculture, fertilizers, pesticides, eutrophication & biomagnifications - Energy resources - renewable & non-renewable resources - wind, solar and tidal - harnessing methods.

UNIT - II ECO SYSTEM AND BIODIVERSITY **9 Periods**

Ecology - ecosystem, physical and chemical components of ecosystem, biological components of ecosystem - forest ecosystem, desert ecosystem and pond ecosystem, Energy flow in ecosystem, nitrogen cycle and carbon dioxide cycle, food pyramid, ecological succession, Biodiversity - types, values of biodiversity, hot spots of biodiversity, endangered and endemic species, conservation of biodiversity – in situ – ex situ conservation.

UNIT - III ENVIRONMENTAL POLLUTION **9 Periods**

Air pollution, classification of air pollutants – sources, effects and control of gaseous pollutants SO_2, NO_x, H_2S, CO, CO_2 and particulates, control methods - cyclone separator and electrostatic precipitator - Water pollution - classification of water pollutants, organic and inorganic pollutants, sources, effects and control of water pollutants Soil pollution - sources, effects and control - Noise pollution - decibel scale, sources, effects and control.

UNIT - IV ENVIRONMENTAL THREATS **9 Periods**

Acid rain, greenhouse effect, global warming and ozone depletion, disaster management, flood, drought, earthquake and tsunami, Threats to biodiversity - destruction of habitat, habit fragmentation - hunting, over exploitation and man - wildlife conflicts, The IUCN red list categories, status of threatened species.

UNIT - V SOCIAL ISSUES AND ENVIRONMENT **9 Periods**

Sustainable development - sustainable technologies, need for energy and water conservation, rain water harvesting, water shed management, waste land reclamation, Pollution control Act, Wild life protection act, Forest conservation act, population growth - exponential and logistic growth, variation in population among nations, population policy, women and child welfare programs, role of information technology in human and health, HIV/AIDS - effects and preventive measures.

LECTURE: 45 PERIODS TUTORIAL: 0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Sharma J.P	*"Environmental Studies", 3rd Edition*	*University Science Press, New Delhi 2009.*
Anubha Kaushik and C.P. Kaushik	*"Environmental Science and Engineering", 3rd Edition*	*New age International Publishers, New Delhi, 2008.*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
R.K. Trivedi	*Hand book of Environmental laws, Rules, Guidelines, Compliances and Standards", Vol.I&II,*	*Environ Media, 2006.*
G. Tyler Miller Jr	*"Environmental Science", 10th Edition*	*Thomson Brooks/Cole Publishing, 2004.*
Gilbert M. Masters	*Introduction to Environmental Engineering and Science, 2nd Edition*	*Pearson Education, 2004.*

COURSE OUTCOMES:

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

CO1: *To know about the various environmental resources, the effective utility and problems accompanied in over exploitation.*

CO2: *To acquire knowledge about the interaction of biosphere with environment and conservation methods of bio diversity.*

CO3: *To be aware of the source of various types of pollution, their ill effects and preventive methods.*

CO4: *To understand the environmental threats, Acid rain, Green house effect and Ozone depletion and natural disasters.*

CO5: *To create an idea about sustainable development and social issues.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	M	L	L	L	L	L	L	L	L	L	L	L	M	L	L
CO 2	L	L	H	L	L	L	M	M	L	M	L	L	L	L	L
CO 3	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L
CO 4	M	L	H	L	L	L	H	H	L	M	L	L	M	L	M
CO 5	M	L	M	L	L	L	H	H	L	L	L	L	M	L	M
16MHS2Z4	M	L	M	L	L	L	M	M	L	L	L	L	M	L	L

L-Low, M-Moderate(Medium), H-High

16MES2Z5 **PROGRAMMING IN C** **Category : ES**

Common to all branches

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- *The Computer and Programming fundamentals*
- *Data types in C and Flow control statements*
- *Functions, Arrays, Pointers And Strings*
- *Bitwise Operators, Preprocessor Directives, Structures and Unions*
- *Structures, List Processing, Input And Output*

UNIT - I COMPUTER AND PROGRAMMING FUNDAMENTALS 9 Periods

Computer fundamentals – Evolution, classification, Anatomy of a computer: CPU, Memory, I/O – Introduction to software – Generation and classification of programming languages – Compiling – Linking and loading a program – Translator – loader – linker – develop a program – software development – Introduction to OS –Types of OS – Algorithms – Structured programming concept.

UNIT - II DATA TYPES AND FLOW OF CONTROL 9 Periods

An overview of C – Programming and Preparation – Program Output – Variables – Expressions, and Assignment, The use of #include, printf(), scanf() – Lexical elements, operators and the C systems – The fundamental data types – Flow of control

UNIT - III FUNCTIONS, ARRAYS, POINTERS AND STRINGS 9 Periods

Functions and storage classes - 1D Arrays – Pointers – Call by reference – Relationship between Arrays and Pointers – Pointer arithmetic and element size – Arrays as function argument – Dynamic memory allocation – Strings – String handing functions – Multidimensional Arrays.

UNIT - IV ARRAY OF POINTERS, BITWISE OPERATORS, PREPROCESSOR DIRECTIVES 9 Periods

Arrays of Pointers – Arguments to main () - Ragged Arrays – Functions as Arguments – Arrays of Pointers to Functions - Type qualifiers.-Bitwise operators and expressions – Masks – Software tools – Packing and unpacking – Enumeration types – The preprocessor directives.

UNIT - V STRUCTURES AND UNIONS, I/O AND FILE OPERATIONS 9 Periods

Structures and Unions – Operator precedence and associativity – Bit fields – Accessing bits and bytes - Input and Output functions – File Processing Functions – Environment variables – Use of make and touch.

LECTURE: 45 PERIODS TUTORIAL: 0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Pradip Dey, Manas Ghosh	*Computer Fundamentals and Programming in C, Second Edition*	*Oxford University Press, 2013.*
Al Kelley, Ira Pohl	*A Book on C-Programming in C, Fourth Edition*	*Addison Wesley, 2001.*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
Stephen G. Kochan	*Programming in C-A complete introduction to the C programming language, Third Edition*	*Sams Publication, 2004.*
Yashavant P. Kanetkar	*Let Us C, 13th edition*	*BPB Publications, 2013.*
Brian W. Kernighan and Dennis Ritchie	*The C Programming Language", Second Edition*	*Prentice Hall Software Series, 1988.*
Stephen Prata	*C Primer Plus, Fifth Edition*	*Sams Publishing, 2005.*

COURSE OUTCOMES:

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

CO1: *Articulate the programming environment [Familiarity]*

CO2: *Write algorithm for solving the given problem statement [usage]*

CO3: *Use right data types and flow control statement [Assessment]*

CO4: *Write programs using functions, arrays, pointers and strings [Usage]*

CO5: *Use right storage classes, preprocessor directives, bitwise operators in programs [Assessment]*

CO6: *Use structures, unions and files [Usage]*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	H	L					L					M	H	H	L
CO 2	H	M	L				M					M	H	H	L
CO 3	H	M					L					M	M	H	L
CO 4	H	M	L				M					M	M	M	M
CO 5	H	M					L					M	H	M	L
CO 6	H	M	L				L					M	M	M	L
16MES2Z5	H	M	L				L					M	H	H	L

L-Low, M-Moderate(Medium), H-High

16MES206 **ENGINEERING MECHANICS** **Category : ES**

Common to all except ECE, CSE and IT branches

L	T	P	C
3	2	0	4

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To analyze the force systems, friction and to study the dynamics of particles, impulse and momentum.*

UNIT - I INTRODUCTION TO MECHANICS AND FORCE CONCEPTS 9+6 Periods

Principles and Concepts – Laws of Mechanics – system of forces – resultant of a force system – resolution and composition of forces – Lami's theorem – moment of a force – physical significance of moment-Varignon's theorem – resolution of a force into force and couple – forces in space – addition of concurrent forces in space – equilibrium of a particle in space.

UNIT - II FRICTION 9+6 Periods

Frictional resistance – classification of friction- laws of friction – coefficient of friction-angle of friction – angle of repose — cone of friction – free body diagram-advantages-equilibrium of a body on a rough inclined plane – non-concurrent force system - ladder friction – rope friction – wedge friction.

UNIT - III GEOMETRICAL PROPERTIES OF SECTION 9+6 Periods

Centroids – Determination by integration – moment of inertia – theorems of moment of inertia –Product of Inertia – Principal moment of inertia of plane areas - radius of gyration.

UNIT - IV BASICS OF DYNAMICS - KINEMATICS 9+6 Periods

Kinematics and kinetics – displacements, velocity and acceleration - Equations of motion – Rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration – motion curves – motion under gravity – relative motion – curvilinear motion of particles – projectiles – angle of projection – range – time of flight and maximum height.

UNIT - V BASICS OF DYNAMICS - KINETICS 9+6 Periods

Newton's second law of motion – linear momentum – D'Alembert's principle, Dynamics equilibrium – work energy equation of particles– law of conservation of energy – principle of work and energy.

Principle of impulse and momentum – Equations of momentum – Laws of conservation of momentum. Impact – Time of compression, restitution, collision – Co-efficient of restitution – types of impact – collision of elastic bodies by direct central impact and oblique impact – collision of small body with a massive body – Kinetic energy of a particle.

LECTURE: 45 PERIODS TUTORIAL: 30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 75 PERIODS

TEXT BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
S.S. Bhavikatti and K.G. Rajasekarappa	*Engineering Mechanics*	*New Age International Pvt Ltd. 1999.*
S.C. Natesan	*Engineering Mechanics*	*Umesh Publications, 5-B north market, Naisarak, Delhi, 2002.*

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
F.B. Beer and E.R. Johnson	*Vector Mechanics for Engineers*	*Tata Mc.Graw Hill Pvt Ltd, 10th Edition, 2013.*
S. Timoshenko and Young	*Engineering Mechanics*	*Mc.Graw Hill, 4th Edition, 1995.*
Irving Shames and Krishna Mohana Rao	*Engineering Mechanics*	*Prentice Hall of India Ltd, Delhi, 2006.*
Domkundwar V.M and Anand V. Domkundwar	*Engineering Mechanics (Statics and Dynamics)*	*Dhanpat Rai and Co. Ltd, 1st Edition, 2006.*
Suhas Nitsure	*Engineering Mechanics*	*Technical Publications, Pune, 1st edition, 2006.*
R.C. Hibbeller	*Engineering Mechanics*	*Prentice Hall of India Ltd, 13th Edition, 2013.*
Vela Murali	*Engineering Mechanics*	*Oxford university Press, 1st Edition,2010.*

COURSE OUTCOMES:

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

CO1: *Analyze the problems related to force systems and friction*

CO2: *Apply concepts of centre of gravity and moment of inertia*

CO3: *Solve problems on dynamics, momentum and impulse*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	M	H	M	L	L				L		L		**H**	**H**	L
CO 2	L	H	L		L				L		L		**H**	**H**	L
CO 3	M	H	M	L	L				L		L		M	M	L
16MES206	M	H	M	L	L				L		L		**H**	**H**	L

L-Low, M-Moderate(Medium), H-High

16MBS207	CHEMISTRY LABORATORY	Category: BS
	Common to Civil, Mechanical, Production	L T P C
	and Industrial Biotechnology branches	0 0 4 2

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *The course is aimed at imparting knowledge of experimental techniques which would be useful for students to apply the practical principles relevant conventional engineering field.*

LIST OF EXPERIMENTS

1. Estimation of hardness by EDTA method.
2. Estimation of chloride by Argentometric method.
3. Determination of dissolved oxygen by Winkler's method.
4. Conductometric titration of mixture of strong acid and weak acid using strong base.
5. Potentiometric titration of ferrous iron by dichromate.
6. Estimation of copper in brass by EDTA method.
7. Estimation of Iron by Spectrophotometry
8. Estimation of HC1 by pH titration.

LECTURE: 0 PERIODS TUTORIAL: 0 PERIODS PRACTICAL: 60 PERIODS TOTAL: 60 PERIODS

REFERENCE BOOKS

AUTHOR NAME	TITLE OF BOOK	PUBLISHER, YEAR OF PUBLICATION
A.O. Thomas,	*Practical Chemistry*	*Scientific Book Centre, Cannanore, 2003.*
Jeffery G H, Basset J. Menthom J, Denney R.C.	*Vogel's Text book of quantitative analysis, 5th Edition*	*EBS, 1988.*

COURSE OUTCOMES:

Upon completion of this practical classes, the students will be able to

CO1: *Understand the nature of hardness, chloride level, pollution level using dissolved oxygen content, iron present in water and analyse them in water.*

CO2: *Apply the EMF and conductometric measurements in quantitative analysis of substances.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	H	M	L	L	M	L	L	L	L	M	L	M	M	L	L
CO 2	H	M	L	L	M	L	L	L	L	M	L	M	M	L	L
16MBS207	H	M	L	L	M	L	L	L	L	M	L	M	M	L	L

L-Low, M-Moderate(Medium), H-High

16MES208	WORKSHOP PRACTICE	Category : ES
	Common to Civil, Mechanical, Production and Industrial Biotechnology Branches	L T P C 0 0 4 2

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To make various basic prototypes in the carpentry trade such as Lap joint, Lap Tee joint, Dove tail joint, Mortise & Tenon joint and Cross-Lap joint.*
- *To make various welding joints such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint.*

LIST OF EXPERIMENTS

1. Introduction to use of tools and equipments in Carpentry, Welding, Foundry and Sheet metal
2. Safety aspects in Welding, Carpentry and Foundry
3. Half lap Joint and Dovetail Joint in Carpentry
4. Welding of Lap joint, Butt joint and T-joint
5. Preparation of Sand mould for cube, conical bush, pipes and V pulley
6. Fabrication of parts like tray, frustum of cone and square box in sheet metal
7. Electrical wiring – simple house wiring
8. Plumbing

LECTURE:0 PERIODS TUTORIAL: 0 PERIODS PRACTICAL: 60 PERIODS TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of this practical classes, the students will be able to

CO1: *Use tools and equipments used in Carpentry, Welding, Foundry and Sheet metal.*

CO2: *Make half lap joint and dovetail joint in carpentry.*

CO3: *Make welded lap joint, butt joint and T-joint.*

Prepare sand mould for cube, conical bush, pipes and V pulley.

CO4: *Fabricate parts like tray, frustum of cone and square box in sheet metal*

CO5: *Carry out minor works/repair related to electrical wiring and plumbing.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1		H	H			M		L	H	M		M	M	M	
CO 2			H			M		L	H	M		M	M	M	
CO 3			H			M		L	H	M		M	M	M	
CO 4			H			M		L	H	M		M	M	M	
CO 5		H	H	H		M		L	H	M		M	M	M	
16MES208		L	H	L		M		L	H	M		M	M	M	

L-Low, M-Moderate(Medium), H-High

16MES2Z9	PROGRAMMING IN C LABORATORY	Category : ES
	Common to all branches	L T P C
		0 0 4 2

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *Data types in C and Flow control statements*
- *Functions, Arrays, Pointers And Strings*
- *Dynamic memory allocation and command line arguments*
- *Bitwise Operators, Preprocessor Directives, Structures and Unions*
- *Structures, List Processing, Input And Output*

PRACTICALS

EXERCISES ILLUSTRATING THE FOLLOWING CONCEPTS:

1. Operators , Expressions and IO formatting
2. Decision Making and Looping
3. Arrays and Strings
4. Functions and Recursion
5. Pointers
6. Dynamic Memory Allocation
7. Structures
8. Unions
9. Files
10. Command line arguments
11. Mini Project

LECTURE: 0 PERIODS **TUTORIAL: 0 PERIODS** **PRACTICAL: 60 PERIODS** **TOTAL: 60 PERIODS**

COURSE OUTCOMES:

Upon completion of this practical classes, the students will be able to

CO1: *Use appropriate data types and flow control statements [Usage]*

CO2: *Write programs using functions, arrays, pointers and strings [Usage]*

CO3: *Write programs using dynamic memory allocation [Usage]*

CO4: *Implement programs using right storage classes, preprocessor directives, bitwise operators [Usage]*

CO5: *Work with command line arguments, structures, unions and files [Usage]*

CO6: *Develop applications using C [Usage]*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	H	M					L			L			H	H	L
CO 2	H	M	L				L			L			H	H	L
CO 3	H	M	L				L			L			M	H	L
CO 4	H	M	L				L			L			M	M	L
CO 5	H	M	L				L			L			L	L	L
CO 6	H	H	H		M		M			L		H	L	L	L
16MES2Z9	H	M	L		L		L			L		L	M	M	L

L-Low, M-Moderate (Medium), H-High

16MBS3Z1 **ENGINEERING MATHEMATICS III** **CATEGORY: BS**

(Common to all Branches)

L	T	P	C
3	2	0	4

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To gain the knowledge of formation of Fourier series*
- *To familiarize with Infinite and finite Fourier transforms functions.*
- *To be familiar with solution of first and second order differential equations.*
- *To acquire knowledge of techniques to solve one and two dimensional partial differential equations concerning to engineering applications.*

UNIT – I FOURIER SERIES (9+6)

Dirichlet's conditions - Full range Expansions - Odd and even functions - Half range sine and cosine series – Parseval's identity on a Fourier series - Harmonic analysis

UNIT – II FOURIER TRANSFORMS (9+6)

Fourier integral theorem (statement only) - Infinite Fourier transform pair - Fourier sine and cosine transform pair - Properties -Transforms of simple functions - Parseval's identity on a Fourier transform - Finite Fourier transforms.

UNIT - III PARTIAL DIFFERENTIAL EQUATIONS (9+6)

Formation of partial differential equations - First order PDE - Standard types and Lagrange's type - Linear partial differential second and higher order with constant coefficients - Homogeneous and Nonhomogeneous types

UNIT - IV BOUNDARY VALUE PROBLEMS (9+6)

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

UNIT – V Z TRANSFORMS (9+6)

Z transforms-properties-Inverse Z transforms-Initial and final value theorems- Convolution theorem-Formation of difference equations- Solution to difference equations of second order difference equations with constant coefficients with Z transform.

Lecture: 45 Periods **Tutorial:30 Periods** **Practical:0 Periods** **Total: 75 Periods**

TEXT BOOKS

1. Veerarajan T, **"Transforms and Partial Differential Equations"** for Semesters III, Tata McGraw Hill Publishing Co., New Delhi, 2015.
2. Kandasamy, Thilagavathy and Gunavathy, **"Engineering Mathematics"** for III Semester B.E/B.Tech, S.Chand& Co, Ramnagar, New Delhi, 2013.

REFERENCE BOOKS

1. *Grewal B .S,* ***"Higher Engineering Mathematics"*** *Khanna Publishers, New Delhi, 43rd Edition,2014.*
2. *Ramana B. V,* ***"Higher Engineering Mathematics"*** *Tata McGraw Hill Co. Ltd., New Delhi, 11th Edition, Reprint, 2010.*
3. *Bali N., Goyal M,* ***"Transforms and Partial differential equations"*** *University Science Press,New Delhi, 2010*
4. *Ray Wylie C and Louis C Barrett,* ***"Advanced Engineering Mathematics"****, McGraw Hill Education(India) Pvt Ltd, New Delhi, 6th Edition, Reprint ,2014.*
5. *Donald.A.McQuarrie,* ***"Mathematical Methods for Scientists and Engineers",****Viva Books Pvt Ltd. New Delhi Ist Edition, Reprint 2015.*

COURSE OUTCOMES

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

CO 1: *Understand the concepts of Fourier series and its construction when discrete and continuous form is known*

CO 2: *Acquire fluency in Fourier transforms in order to solve improper integrals.*

CO 3: *Understand the standard and special types of partial differential equations.*

CO 4: *Gain fluency in solving boundary value problems.*

CO 5: *Understand the Z transform methods to find solutions of difference equations.*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	H							H			M	M	
CO2	M	H	M							M			L	L	
CO3	H	M								L			L	M	
CO4	H	H	M			M				M	M		L	L	
CO5	M	M	M										L	L	
16MBS3Z1	H	H	M			L				M	L		L	L	

L-Low, M-Moderate(Medium), H-High

16MES302 **STRENGTH OF MATERIALS** **CATEGORY: ES**

(Common to Production Engineering)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MES206 Engineering Mechanics

COURSE OBJECTIVES:

- *To understand the basic concepts of stress, strain, shear force, bending moment and deflection for different types of loading conditions.*
- *To understand the deflection of beams, theory of columns and applications of torsion.*

UNIT - I: STRESS AND STRAIN (9)

Stress and strain at a point-Tension, compression, shear stresses - Hooke's law - Compound bars – lateral strain - Poisson's ratio -Volumetric strain - Bulk modulus - Relationship among elastic constants – stress strain diagrams for mild steel, cast iron-Ultimate stress - Yield stress-Factor of safety - Thermal stresses - Thin cylinders - Strain energy due to axial force - Resilience- Stress due to gradual load, suddenly applied load and Impact load.

UNIT - II: SHEAR FORCE AND BENDING MOMENT (9)

Beams – Types of Beams - Types of loads, supports - Shear force – Bending moment – shear forces and bending moment diagrams for cantilever, simply supported and over hanging beams with concentrated , uniformly distributed and uniformly varying load-Relationship between rate of loading, shear force, bending moment- Point of contra flexure.

UNIT - III: THEORY OF BENDING AND COMPLEX STRESSES (9)

Theory of bending-Bending equation-Section Modulus-Stress distribution at a cross section due to bending moment and shear force for cantilever, simply supported beams with point, UDL loads(Rectangular, circular, I & T sections only) -combined direct and bending stresses, Kernel of section (Rectangular, Circular Sections only). 2D State of stress - 2D Normal and shear stresses on any plane-Principal stresses and Principal planes-Principal Strains and direction-Mohr's circle of stress.

UNIT - IV: DEFLECTION OF BEAMS AND THEORY OF LONG COLUMNS (9)

Determinations of deflection curve – Relation between slope, deflection and radius of curvature – Slope and deflection of beam at any section by Macaulay's method - Concept of Conjugate beam method (Theory only)- Euler's theory of long Columns- Expression of crippling load for various end conditions-Effective length-Slenderness ratio-limitations of Euler equation - Rankine formula for columns.

UNIT - V: THEORY OF TORSION (9)

Torsion of shafts - Torsion equation - Polar modulus- Stresses in Solid and Hollow circular shafts - Torsional rigidity - Power transmitted by the shaft – Importance of angle of Twist - Strain energy due to Torsion - Modulus of rupture – Torsional resilience – Combined bending and Torsion- Stresses in helical springs - Deflection of helical spring-Leaf springs.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Sadhu Singh, **"Strength of Materials"** , Khana Publishers, New Delhi, 2000.*
2. *Rajput.R. K ., **"Strength of Materials"** , S. Chand & Company Ltd., New Delhi 2002.*
3. *James M.Gere , **"Mechanics of Materials"**, Thomson India, Brooks/cole, 2006.*

REFERENCE BOOKS:

1. *Dr.B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain., **"Mechanics of Materials"**, Lakshmi Publications Pvt Ltd, New Delhi, 2002.*
2. *Kazimi, **"Solid Mechanics"**, Tata McGraw Hill, New Delhi, 1998.*
3. *Robert L.Mott, **"Applied Strength of Materials"**, PHI Learning Pvt. Ltd, New Delhi, 2009.*
4. *Jindal U C, **"Textbook on Strength of Materials"**, Asian Books Pvt. Ltd., 2007.*
5. *Ramamrutham S and Narayan R, **"Strength of Materials"**, Dhanpat Rai and Sons, New Delhi, 2000.*

COURSE OUTCOMES:

On completion of this course, students will be able to

***CO1**: Find the stress, strain and modulus for different materials.*

***CO2**: Understand the knowledge of shear force and bending moment diagrams of beams.*

***CO3**: Calculate the complex stresses in beams with different loading conditions.*

***CO4**: Find the deflection behaviour of beams and slender columns.*

***CO5**: Apply the concepts of torsion in shafts and springs.*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	L	H		M		L							L	L	L
CO2	L	M	H	L	M					L			L		L
CO3		H	L	H	M					L			L		L
CO4	M	H	L	M	L								L		L
CO5	L	H		M		L							L		L
16MES302	L	H	L	M	M	L				L			L	L	L

L-Low, M-Moderate(Medium), H-High

16MES303 ELECTRICAL MACHINES AND DRIVES CATEGORY: ES

(Common to Production Engineering)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MES105 Basics of Electrical and Electronics Engineering

COURSE OBJECTIVES:

- *To understand the fundamental of energy conversion and to study the construction, principal of operation, characterization of DC machines, AC machines and various drives used.*

UNIT – I DC MACHINES (10)

Construction – Generator Principle – EMF equation – Characteristics of different types of DC generators – Motor principle – Torque equation – Characteristics of different types DC motors – Starters – Speed control – Electric braking – Swinburne's test – Brake test.

UNIT – II SYNCHRONOUS MACHINES (9)

Alternators – Types and constructional features – EMF equation – Voltage regulation – Synchronous motor principle – V and inverted V curves – Hunting – Methods of starting – Applications.

UNIT – III INDUCTION MACHINES (10)

Construction of three-phase induction motors – Principle of operation – Torque-slip characteristics – Starting and speed control methods – Single phase induction motor – Types – Methods of starting – Applications – Universal motor.

UNIT – IV SOLID STATE SPEED CONTROL (Power circuits and Qualitative treatment only) (8)

Control of DC drives using rectifiers and choppers – Control of three phase induction motor using stator voltage control – V/f control– Rotor resistance control– Slip power recovery schemes.

UNIT – V SELECTION OF DRIVES AND SPECIAL MOTORS (8)

Types of electrical drives – Factors influencing the choice of electric drives – Loading conditions and classes of duty – Determination of power rating – Selection of motor for steel rolling mills, paper mills, sugar mills, textile mills and machine tool applications – DC and AC servomotors – Stepper motors.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Theraja B.L and Theraja A.K., **'A Test book of Electrical Technology'**, volume – II, S.Chand & Co., 2006.*
2. *Pillai S.K., **'A first course on Electrical Drives'**, New Age International Publishers.,New Delhi, 2nd Edition (Reprint) 2010.*

REFERENCE BOOKS:

1. *De N.K and Sen P.K.**, 'Electric Drives'**, PHI, 2009.*
2. *Deshpande M.V., **'Electric motors application and control'**, PHI, 2011.*
3. *Sugandhi R.K. and Sugandhi K.K., **'Thyristors: Theory and applications'**, New Age International Publishers, 2nd edition (reprint) 2009.*
4. *Dubey G.K., **'Fundamentals of Electric Drives'**, Alpha Science International Ltd., 2002.*
5. *Vedam Subramaniam., **'Electric Drives: Concepts and Applications'**, McGraw Hill, 2011.*

COURSE OUTCOMES:

On completion of this course, students will be able to

***CO 1**: Select and utilize various electrical machines*

***CO 2**: Employ effective control techniques to electrical motors*

***CO 3**: Identify suitable synchronous machines for real time applications*

***CO 4**: Design suitable induction machines for real time applications*

***CO 5**: Select appropriate electrical drive for various industrial applications*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	M			H			M	L			M		H	
CO2	L		M					M		M		M	M		
CO3	L			M							L	M			H
CO4		H									H	M		M	
CO5	H		L		L	M		M		L			M		
16MES303	L	L	L	L	L	L		L	L	L	L	M	L	L	L

L-Low, M-Moderate(Medium), H-High

16MPC304 MANUFACTURING TECHNOLOGY I CATEGORY:PC

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

* *To expose the students to various casting, joining, metal forming and metal cutting processes*

UNIT – I METAL CASTING PROCESSES (09)

Introduction to Concepts of Manufacturing Process -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 – Sand Casting defects – Inspection methods

UNIT - II JOINING PROCESS (10)

Fusion welding processes – Types of Gas welding – Equipments used – Flame characteristics – Filler and Flux materials - Arc welding equipments - Electrodes –Coating and specifications – Principles of Resistance welding – Spot/butt, seamwelding – Percusion welding - Gas metal arc welding – Flux cored – Submerged arc welding – Electro slag welding – TIG welding- Adhesives : Types and applications- Brazing and soldering process.

UNIT - III BULK DEFORMATION PROCESSES (9)

Hot working and cold working of metals – Forging processes – Open and close die forging – Types of Forging Machines – Typical forging operations – Rolling of metals – Flat strip rolling – Types of Rolling mills – Tube piercing – Principles of Extrusion – Types of Extrusion – Hot and Cold extrusion – Principle of rod and wire drawing.

UNIT - IV SHEET METAL FORMING AND PLASTIC COMPONENTS (9)

Typical shearing operations, bending and drawing operations – Formability of sheet metal – Metal spinning – Magnetic pulse forming – Super plastic forming – Types and characteristics of plastics- Moulding of Thermoplastic-Working principle and application of Injection moulding, compression moulding and transfer moulding.

UNIT - V METAL CUTTING (TURNING) PROCESS (8)

Various types of lathe- CNC lathe, Turing centre- Construction details of centre Lathe-Work holding devices: self centering three jaw chuck, independent four jaw chuck, collets, face plates, dog carriers, centers and mandrels- Lathe operations.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Kalpakjian, S., **"Manufacturing Engineering and Technology"**, Pearson Education India 7th Edition, 2013.*
2. *Sharma, P.C**., "A Text book of Production Technology"**, S. Chand and Co. Ltd., 2009.*

REFERENCE BOOKS:

1. *HajraChoudhury, SK **"Elements of Workshop Technology", Vol. I and II"**, Media Promotors Pvt Ltd., Mumbai, 2001*
2. *P.N. Rao, "**Manufacturing Technology Foundry, Forming and Welding"**, Tata McGraw Hill 3rd Edition, 2009*
3. *Roy. A. Lindberg, "**Processes and Materials of Manufacture"**, PHI / Pearson Education, 4th Edition, 2008.,*
4. *R.K. Rajput, "**Manufacturing Technology"**, Laxmi Publication Pvt Ltd, 1st Edition, 2007.*
5. *M. Adithan and A.B.Gupta, "**Manufacturing Technology"**, New Age International Pvt Ltd, 2003.*

COURSE OUTCOMES:

On completion of this course, students will be able to

***CO1:** Apply the principles of metal casting for engineering applications.*

***CO2:** Select appropriate joining process for real time applications.*

***CO3:** Apply the bulk deformation processes according to industrial needs.*

***CO4**: Select and use appropriate sheet metal operations in industries.*

***CO5**: Apply various lathe operations for machining.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	M			L			L		L		M	L	L
CO2	L	L	M			L			L		L		M	L	L
CO3	L	L	M			L			L		L		M	L	L
CO4	L	L	M			L			L		L		M	L	L
CO5	L	L	M			L			L		L		M	L	L
16MPC304	L	L	M			L			L		L		M	L	L

L-Low, M-Moderate(Medium), H-High

16MPC305 **ENGINEERING METALLURGY** **CATEGORY:PC**

(Common to Production Engineering)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. *16MBS103 Applied physics*
2. *16MBS2Z3 Materials Science*

COURSE OBJECTIVES:

- *To study the phase diagrams, various heat treatment methods, principles of foundry, welding and powder metallurgy and to acquire knowledge on testing materials, properties and application of various methods.*

UNIT – I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS (9)

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions, Iron – Iron carbide equilibrium diagram.

UNIT – II HEAT TREATMENT AND SURFACE TREATMENT (9)

Definition – Full annealing, process annealing, stress relief, recrystallisation - spheroidizing –normalising, hardening and tempering of steels – austempering, martempering - Isothermal transformation diagrams – cooling curves superimposed on I.T diagram- CCR - hardenability, Jominy end quench test - Case hardening, carburising, nitriding, cyaniding, carbonitriding–Flame and Induction hardening.

UNIT – III FERROUS AND NON FERROUS METALS (9)

Plain carbon steels – alloy steels - Effect of alloying elements (Mn, Si, Cr, Mo, V , Ni, Ti & W) on properties of steel - stainless and tool steels – Gray, White, Malleable, Spheroidal graphite - alloy cast irons – heat resistant steels and die steels. Copper, Aluminium, Nickel, Magnesium, Titanium, Lead, Tin - Important alloys - their composition, properties and applications - Material Specification and standards

UNIT – IV FOUNDRY AND POWDER METALLURGY (9)

Solidification of pure metals and alloys – melting – super heating – fluxing – micro and macro segregation – hot tears – heat transfer and structural change - Production of powders, mixing, blending, compacting, sintering and hot pressing – secondary operations- application of powder metallurgy – advantages and limitations.

UNIT – V WELDING METALLURGY AND TESTING OF MATERIALS (9)

Weldability – heat distribution during welding and thermal effects on parent metals – HAZ – factors affecting HAZ - hardening, cracking, distortion and residual stresses – stress relief treatment of welds – Mechanical tests - tension, compression, impact, hardness, Non Destructive Testing basic principles and testing method for Radiographic testing, Ultrasonic testing, Magnetic Particle inspection and Liquid penetrant inspection test - Eddy current testing.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Higgins R.A.,**"Engineering Metallurgy",** 5th edition, EIbs,1983.*
2. *Dieter, G.E., "**Mechanical Metallurgy"**, SI metric edition,. McGraw-Hill, ISBN 0-07-100406-8, 1988,*
3. *Sydney H.Avner,**"Introduction to Physical Metallurgy",** Tata McGraw Hill Book Company, 1994.*

REFERENCE BOOKS:

1. *William D Callsber "**Material Science and Engineering**", Wiley India pvt Ltd 2007.*
2. *Lakhtin Yu., "**Engineering Physical Metallurgy and Heat Treatment**", Mir Publisher, 1985.*
3. *Kenneth G.Budinski and Michael K.Budinski "**Engineering Materials**" Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.*
4. *GUY.A.G., **"Elements of Physical Metallurgy",** Oxford & IBH Pub.Co,1990.*
5. *O.P.Khanna,**"Material Science And Metallurgy",** Dhanpat Rai Publication ,2011*

COURSE OUTCOMES:

On completion of this course, students will be able to

***CO 1:** Predict the alloy components and its composition variation with respect to temperature changes.*

***CO 2:** Select suitable materials and heat treatment methods for various industrial applications.*

***CO 3:** Understand the ferrous and nonferrous materials and their application*

***CO 4:** Apply the knowledge of foundry and powder metallurgy to solve various industrial production processes.*

***CO 5:** Gain knowledge about materials testing methods and welding techniques to meet industrial requirements.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L				M			L				L	M		
CO2	M		H		H								H	M	
CO3	H	M			M								M	H	L
CO4	L	M			M								L	M	
CO5	L					M	H				L				
16MPC305	M	L	L		M	L	L	L			L	L	M	L	L

L-Low, M-Moderate(Medium), H-High

16MPC306 **FLUID MECHANICS AND MACHINERY** **CATEGORY:PC**

(Common to Production Engineering)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MES206 Engineering Mechanics

COURSE OBJECTIVES:

- *To understand the basic principles in fluid mechanics and behavior study of fluid particles under rest and moving conditions.*
- *To understand the moment principle in fluid mechanics and its application in flow through pumps and turbines.*

UNIT - I: FLUID PROPERTIES **(9)**

Units and Dimensions – Fluid properties – Density, Specific gravity, Viscosity, Surface tension, Capillarity, Compressibility and Bulk modulus – Pascal's Law – pressure measurements – manometers - Fluid statics - Total pressure and centre of pressure on submerged surfaces.

UNIT - II: FLUID KINEMATICS AND DYNAMICS **(9)**

Types of fluid flow and flow lines – control volume – continuity equation in one-dimension and three dimension – velocity potential and stream function - Energy equation – Euler and Bernoulli's equations – Applications of energy equations- Flow meters - Laminar and Turbulent flow through pipes - Governing Equations.

UNIT - III: MOMENTUM PRINCIPLE **(9)**

Impulse momentum principle - Application of momentum principle - Impact of Jet – Force exerted by a jet on normal, inclined and curved surfaces for stationary and moving cases -Angular momentum principle - construction of velocity vector diagram.

UNIT - IV: HYDRAULIC TURBINES **(9)**

Classification – construction, working principles and design of Pelton wheel, Francis and Kaplan Turbines - head, losses, work done and efficiency - specific speed – operating characteristics - Governing of Turbines.

UNIT - V: PUMPS **(9)**

Classification of pumps - Centrifugal pump - working principle - discharge, work done and efficiencies – Gear oil and Multistage pumps - Reciprocating pumps - work done and efficiencies - negative slip - flow separation conditions - air vessels - indicator diagram and its variation - savings in work done.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Rajput R. K., **"A text Book of Fluid Mechanics and Machinery"**, S. Chand and Company, New Delhi, 2002.*
2. *Ramamrutham S. and Narayanan R., **"Fluid Hydraulics and Fluid Machines"**, Dhanpat Rai Publishing House (P) Ltd, New Delhi, 2000.*
3. *Modi P. N. and Seth S. M., **"Hydraulics and Fluid Mechanics including Hydraulic Machines"**, Standard book house, Delhi, 2002.*

REFERENCE BOOKS:

1. *Streeter, Victor L . and Wylie, E. Benjamin, **"Fluid Mechanics"** , McGraw Hill Ltd., 1998.*
2. *Natarajan M. K., **"Fluid Machines"**, Anuradha Agencies, Vidayal Karuppur, Kumbakonam, 1995.*
3. *Kumar K. L., **"Engineering Fluid Mechanics"**, Eurasia Publishing House (P) Ltd., New Delhi, 2000.*

COURSE OUTCOMES:

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

***CO 1:** Identify the importance of fluids properties and fluid principles at rest.*

***CO 2**: Know the physical behavior of fluids system and equations under moving conditions.*

***CO 3**: To apply the concept of momentum principle at stationary and moving vanes.*

***CO4:** To conduct the performance test on different types of turbines.*

***CO5**: To conduct the performance study and selection of pumps for different applications*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	L	L	M								L	M	
CO2	H	M	L	M	L								M	L	
CO3	L	L	M	H	L								L	M	
CO4	L	M	M	H	L					L			M	L	
CO5	L	M	M	H	L					L			L	M	
16MPC306	M	M	M	H	L					L			L	M	

L-Low, M-Moderate(Medium), H-High

16MES307 ELECTRICAL ENGINEERING LABORATORY CATEGORY:ES

L	T	P	C
0	0	4	2

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To give hands on training for measuring DC/AC electrical parameters by conducting basic tests on DC / AC machines and analyzing their performance.*

LIST OF EXPERIMENTS

1. O.C.C and load-test on separately Excited DC generator
2. O.C.C and load-test on DC shunt generator
3. Swinburne's test
4. Speed control of DC shunt motor
5. Load test on DC shunt motor
6. Load test on DC compound motor
7. Load test on DC series motor
8. Mechanical and iron losses of 3-phase induction motor
9. Load test on 3-phase induction motor
10. Load test on 1-phase induction motor
11. Regulation of 3-phase alternator by EMF & MMF methods
12. Load test on 3-phase alternator
13. Study of induction motor starters

Lecture: 0 Periods Tutorial:0 Periods Practical:60 Periods Total: 60 Periods

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1*: Perform suitable experiments to analyze the performance of DC machines and AC machines.*

CO 2*: To understand the concepts of working principles of electrical machines.*

CO 3*: Select electrical machines for appropriate applications*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L				M			M	L	M		H	M		
CO2	M				H			M	M	M		M			H
CO3	L			M				H				L		M	
16MES307	L			L	M			M	L	L		M	L	L	L

L-Low, M-Moderate(Medium), H-High

16MES308 **STRENGTH OF MATERIALS AND FLUID MACHINERY LABORATORY** **CATEGORY:ES**

(Common to Production Engineering)

L	T	P	C
0	0	4	2

PRE-REQUISITES:

16MES302 Strength of Materials

16MPC306 Fluid Mechanics and Machinery

COURSE OBJECTIVES:

- *To understand the basics of different testing methods for different materials.*
- *To study the behaviour of fluid system at rest and motion and performance analysis of pumps and turbines.*

STRENGTH OF MATERIALS LABORATORY

LIST OF EXPERIMENTS:

1. Tension Test on steel rods using Universal Testing Machine.
2. Bending Test on rolled steel Joist Beam.
3. Double shear test on mild steel rod.
4. Torsion Test on Mild steel rod
5. Tension and Compression Test on Springs
6. Deflection test on simply supported aluminium beam
7. Deflection Test on Cantilever Beam
8. Hardness tests on metals like Mild Steel, Brass, Copper and Aluminium
9. Bend Test on Steel rod
10. Compression Test
11. Impact test-izod and charpy

FLUID MECHANICS AND MACHINERY LABORATORY

LIST OF EXPERIMENTS:

1. Determination of Darcy's friction factor
2. Calibration of Flow Meters
3. Flow through Mouth Piece
4. Performance study on Centrifugal pump
5. Performance study on reciprocating pump
6. Performance study on Submersible Pump
7. Performance study on Gear oil Pump
8. Load test on Pelton Wheel Turbine
9. Load test on Kaplan Turbine

Lecture: 0 Periods **Tutorial:0 Periods** **Practical:60 Periods** **Total:60 Periods**

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: *Apply knowledge of compression, tension, shear and torsion testing procedures on materials.*

CO2: *Know the deflection and bending behaviour of different types of beams*

CO3*: Find the hardness of different metals*

CO4: *Find the flow properties of fluids.*

CO5: *Conduct performance tests on pumps and turbines and draw the performance curves.*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M	L	L					M				M	H	
CO2	M	H	L	M	L				L				L	M	
CO3	L	H		M		L			L				L	L	
CO4	M	H	L	L	M				L				M	M	
CO5	L	M	M	H	L				L	L			L	H	
16MES308	M	H	L	M	L	L			L	L			L	M	

L-Low, M-Moderate(Medium), H-High

16MBS401 **NUMERICAL METHODS** **CATEGORY: BS**

(Common to Civil, Mechanical and Electrical Engineering)

L	T	P	C
3	2	0	4

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To familiarize with numerical solutions of equation with one variable and system of equations.*
- *To obtain the knowledge of numerical interpolation, numerical differentiation and numerical integration.*
- *To acquire knowledge of numerical solution to first order ordinary differential equations using single and multi step techniques.*
- *To gain the knowledge of numerical solution to second order partial differential equations using explicit and implicit methods.*

UNIT - I SOLUTIONS OF EQUATIONS AND EIGEN VALUE PROBLEMS (9+6)

Iterative method- Newton Raphson method for single variable and simultaneous equations with two variables - Solutions of linear system of equations - Gauss Elimination, Gauss Jordan, Gauss Seidel method - Eigenvalue of a Matrix by Power method.

UNIT - II INTERPOLATION (9+6)

Operators - Relation between the operators-Newton's divided difference formula - Lagrange's and Hermite's polynomials - Newton Forward and backward difference formula - Stirling's and Bessel's central difference formulae.

UNIT – III NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION (9+6)

Numerical approximation of derivatives using interpolation polynomials - Numerical integration by Trapezoidal, Simpson's one third and Simpson's three eighth rules - Two point and three point Gaussian quadrature formula - Double integration using Trapezoidal and Simpson one third rule - Difference equation.

UNIT - IV NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (9+6)

Taylor series method - Euler method - Modified Euler method - Fourth order Runge Kutta method for solving first order equations - Predictor and corrector methods: Milne's and Adam Bashforth methods.

UNIT - V NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (9+6)

Finite difference solutions for the second order ordinary differential equations-Finite difference solutions for one dimensional Heat Equation (Both Explicit and Implicit Methods) –One dimensional wave equation- Laplace and Poisson equation.

Lecture: 45 Periods Tutorial:30 Periods Practical:0 Periods Total: 75 Periods

TEXT BOOKS

1. *Kandasamy P, Thilagavathy K and Gunavathy K, **" Numerical Methods"**, S.Chand & Co, Ramnagar, New Delhi, Reprint 2013.*
2. *Veerarajan T and Ramachandran T, **"Numerical Methods with Programming in C",** McGraw Hill Education Pvt Ltd, New Delhi, Ist Edition, Reprint, 2016.*

REFERENCE BOOKS

1. *Grewal B S., **"Higher Engineering Mathematics"**, Khanna Publishers, New Delhi, 43rd Edition,2014.*
2. *Balagurusamy E, **"Numerical Methods"**, McGraw Hill Education Pvt Ltd, New Delhi, I Edition Reprint, 2016.*
3. *Dr.Manish Goyal, **"Statistics and Numerical Methods"**, University Science Press, New Delhi,2010*
4. *Dr. J.S. Chitode, **"Numerical Methods"**, Technical Publications, Pune, 2010.*
5. *Ken F.Riley , Mike P.Hobson and Stephen J. Bence, **"Fundamentals of Engineering Numerical Analysis"**, Cambridge University Press, New Delhi, 2015.*

COURSE OUTCOMES

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

***CO 1**: Understand the numerical solutions to algebraic, exponential, logarithmic, transcendental and linear system of simultaneous equations.*

***CO 2**: Acquire fluency in numerical interpolation techniques with equal and unequal intervals.*

***CO 3**: Understand the techniques of finite differences to apply for numerical differentiation, numerical quadrature and numerical cubature.*

***CO 4**: Understanding numerical solution to first order ordinary differential equations by different methods like single step and multistep etc.,.*

***CO 5**: Understanding numerical solution to second order partial differential equations by different methods using finite differences.*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	L								M			M	H	
CO2	H			H						H			M	H	
CO3	H	M	M			L				H	M		L	H	
CO4	H	H								H	H		M	H	
CO5	H	H								H	H		L	H	
16MBS401	H	M	L	L		L				H	M		L	M	

L-Low, M-Moderate(Medium), H-High

16MES402 APPLIED ELECTRONICS AND MICROPROCESSORS CATEGORY:ES

(*Common to Production Engineering)*

L	T	P	C
3	0	0	3

PRE-REQUISITES

16MES105 Basics of Electrical and Electronics Engineering

COURSE OBJECTIVES:

* *To equip the students with the basic knowledge of analog and digital electronic circuits and microprocessor*

UNIT - I ANALOG ELECTRONIC CIRCUITS (9)

Review of characteristics of transistors - Need for biasing – DC Load line analysis - Biasing of BJT-Types of Biasing - Fixed and Self biasing - RC Coupled amplifier - Class A Power amplifier - Class B pushpull amplifier - Distortion in amplifiers. Concept of feedback - Oscillators - Barkhausen criterion - RC phase shift oscillator - Hartley Oscillator - Colpitts Oscillator

UNIT – II DIGITAL CIRCUITS (9)

Binary number system – AND, OR, NOT, NAND, NOR and XORgate – Combinational circuits - Adders and subtractors. Flip flops – RS flip flop, JK, D, T flip flops. A/D and D/A converters - weighted resistor DAC -R-2R ladder DAC - servo tracking A/D - successive approximation A/D converter -Dual slope ADC - Memories - ROM - EPROM – EEPROM-RAM

UNIT – III 8085 ARCHITECTURE AND PROGRAMMING (9)

Block diagram of microcomputer – Architecture of 8085 – Pin configuration – Instruction formats - Instruction set –Addressing modes – Simple assembly language programs.

UNIT – IV TIMING DIAGRAM AND INTERRUPTS (9)

Instruction cycle - machine cycle -Timing diagram: OP code fetch cycle, Memory and I/O read cycle, memory and I/O write cycle, interrupt acknowledge machine cycle. Interrupts - Hardware Interrupts - Vectored Interrupts - Non-vectored interrupts – Priority interrupts - Data transfer schemes - synchronous transfer, asynchronous transfer, interrupt driven transfer and DMA transfer

UNIT – V INTERFACING AND APPLICATIONS (9)

Interfacing of Input and output devices – Applications of microprocessor - Temperature control – Stepper motor control – Traffic light control- Digital clock- EPROM Programmer.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

1. *S.Salivahanan, N.Sureshkumar and A.Vallavaraj, "**Electronic Devices and Circuits**", 2nd Edition,Tata McGrawHill, 2008.*
2. *Morris Mano M., **"Digital Design"**, Prentice Hall Of India Pvt. Ltd. 2008.*
3. *Ramesh S. Goankar, **"Microprocessor Architecture and Programming and Applications 8085 / 8080a"**, Penram International Publishing (India) 2004.*

REFERENCE BOOKS:

1. *Mathur S.P., Kulshreshtha D.C., Chadha P.R. **"Electronic Devices and Applications and Integrated Circuits"**, Umesh Publications,2004.*
2. *Krishna Kant, "**Microprocessor and Microcontroller Architecture, Programming and System Design using 8085,8086, 8051 and 8096**", PHI, 2011.Ajit Pal, **"Microprocessor Principles and Applications"**, Tata McGraw Hill, New Delhi 1999.*
3. *Allen Mottershead "**Electronic Devices and Circuits**", Prentice Hall of India, 2008.*
4. *Charles H.Roth, Jr, "**Fundamentals of Logic Design**", 4th Edition, Jaico Publishing House, 2006.*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

***CO1:** Knowledge about bipolar junction and field effect transistors.*

***CO2:** Knowledge on the design of amplifiers and oscillators.*

***CO3:** Knowledge about combinational and sequential logic circuits.*

***CO4:** Basic knowledge about A/D and D/A converters.*

***CO5**: In-depth knowledge on architecture and programming concepts of 8085 microprocessor.*

***CO6**: Exposure to various interfacing circuits for real time applications.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H		L										H		
CO2	H		L										H		
CO3	H		L										H		
CO4	L												H		
CO5	M		M										H		
CO6	M		M										H		
16MES402	M		L										H		

L-Low, M-Moderate(Medium), H-High

16MPC403 **KINEMATICS OF MACHINES** **CATEGORY:PC**

PRE-REQUISITES:

16MES107 Engineering Graphics
16MES206 Engineering Mechanics

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

* *To familiarize students with the basic of mechanisms, friction drives, to build confidence on the basics of gear theory and its nomenclature.*

UNIT - I BASICS OF MECHANISMS (9)

Terminology and definition – Degree of freedom– Higher and Lower pair – Mobility – Grashoff's law – Various types of Mechanisms- Description of mechanisms-Inversions of four bar chain and slider crank chains – Mechanical advantage – Transmission angle - Springs as links- Practical considerations- pin joints vs sliders,short links, linkages vs cams

UNIT - II KINEMATIC ANALYSIS (9)

Velocity and acceleration analysis on simple mechanisms – Graphical and analytical techniques- Instantaneous center of velocity – Coriolis component – Klein's construction for slider crank chain.

UNIT - III FRICTION DRIVES (9)

Belt and rope drive – Open and cross belt drive – Belt materials – Creep and slip - Ratio of tensions – Effect of centrifugal force – condition for maximum power – Friction in Journal Bearing - Flat pivot bearing - Friction clutches – Single plate – Multi plate – Cone clutches-Brakes - Shoe brake and Internal Expanding brake only.

UNIT - IV CAMS (9)

Types of cams and followers – Determination of cam profiles, pressure angles for SHM, uniform acceleration and retardation with reciprocating and oscillating followers – Knife-edge, roller and flat – practical design considerations- Special cams and its applications.

UNIT - V GEARS (9)

Gear terminology- Types of gearing – Pressure angle and undercutting - Law of gearing –Interference – gear corrections - Gear trains – Simple, compound, reverted and epicyclic.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Thomas Bevan, **"Theory of Machines"**, Pearson Education Limited, 2010*
2. *Rattan S S, **"Theory of Machines"**, Tata McGraw -Hill Publishers, New Delhi, 2009.*

REFERENCE BOOKS:

1. *Shigley J.E And Uicker J.J,* ***"Theory of Machines and Mechanisms"****, McGraw Hill Inc,1995.*
2. *V.P.Singh,* ***"Theory of Machines"****, Dhanapatrai & Sons, 2005*
3. *George H.Maritn, "****Kinematics and Dynamics of Machines",*** *Waveland PrInc, 2002.*
4. *R L Norton, "****Kinematics and Dynamics of Machinery"****, McGraw-Hill, 2009.*
5. *C. E. Wilson, P. Sadler, "****Kinematics and Dynamics of Machinery"****, 3rd edition, Pearson Education, 2014.*

COURSE OUTCOMES:

At the end of the course students will be able to

CO1*: Design mechanisms for practical applications.*

CO2*: Synthesis of mechanisms for given conditions.*

CO3*: Select appropriate type of friction drives gear for a specific application.*

CO4*: Construct cam profile for given follower motion.*

CO5*: Sizing the gear or gear trains.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	L	M	L	L	L	H	L	L	L	H	H	M
CO2	H	H	M	L	M	L	M	L	H	L	L	L	H	H	M
CO3	H	H	H	L	M	L	M	L	M	L	L	L	H	H	M
CO4	H	M	H	L	M	L	H	L	L	L	L	L	H	M	M
CO5	H	H	M	L	M	L	M	L	M	L	L	L	H	M	M
16MPC403	H	H	H	L	M	L	M	L	M	L	L	L	H	H	M

L-Low, M-Moderate(Medium), H-High

16MPC404 **ENGINEERING THERMODYNAMICS** **CATEGORY:PC**

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MBS103 Applied physics

16MBS104 Engineering chemistry

COURSE OBJECTIVES:

* *To expose thermodynamic concepts, processes and cycles for analyzing the thermodynamic systems*

UNIT - I CONCEPT OF THERMODYNAMICS (9)

Basic definitions, Microscopic and Macroscopic approach, Types of systems – Thermodynamic processes – Point and Path function – Thermodynamic equilibrium – Quasi-static process. Heat and work – Zeroth law – First law of thermodynamics – Applications to closed and open systems – Steady flow processes – applications

UNIT - II SECOND LAW OF THERMODYNAMICS AND ENTROPY (9)

Limitations of First law – Kelvin-Plank and Clausius statements – Heat engines – Refrigerators – heat pumps- efficiency and COP – Carnot cycle – Entropy – principle of increase in entropy – reversibility and irreversibility – applications.

UNIT - III IDEAL AND REAL GASES (9)

Equation of state – Ideal and Real gases – Properties calculations - Generalized compressibility chart - Vanderwaal's Equation – specific heats C_p and C_v - Joule-Thomson coefficient – ideal gas mixtures.

UNIT - IV COMBUSTION (9)

Fuels – Combustion equations- Stoichiometric air-fuel ratio – Exhaust and flue gas analysis – practical analysis of combustion products – Dissociation – internal energy and enthalpy of reaction – Enthalpy of formation – Calorific value of fuels – power plant thermal efficiency – practical determination of calorific values – air fuel – vapour mixtures.

UNIT - V PROPERTIES OF STEAM AND VAPOUR POWER CYCLE (9)

Properties of steam – use of steam tables and Mollier chart – dryness fraction calculations. Basic Rankine cycle – Rankine cycle with reheating and regeneration – Application of Binary vapour cycle.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Nag. P.K., "**Engineering Thermodynamics"**, Tata McGraw Hill Company, 5th Edition, 2013.*
2. *Yunus Cengel, **"Thermodynamics"** Tata McGraw Hill Company, 8th Edition, 2014*

REFERENCE BOOKS:

1. *Kothandaraman, C.P., **"Thermal Engineering",** Dhanpat Rai & Sons, 1998.*
2. *Holman, J.P., **"Thermodynamics"** McGraw Hill Company, 2000.*
3. *Rajput, R.K. **"Thermal Engineering"** Laxmi Publications 8th Edition. 2010.*
4. *Ballaney P.L., **"Thermal Engineering",** Khanna Publisher. 1996.*
5. *Mahesh. M. Rathore, "**Thermal Engineering**", Tata Mc Graw Hill Education Private Limited 1st edition, 2010.*

COURSE OUTCOMES:

On completion of this course, students will be able to

***CO 1:** Apply thermodynamic principles to real life thermodynamic problems*

***CO 2:** Analyze the principles of entropy generation*

***CO 3**: Identify the characteristics of gases*

***CO 4**: Apply the principles of combustion to thermal analysis problems*

***CO 5:** Appreciate and analyze the vapour power cycles*

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M			M	L				H	L	M	M
CO2	H	H	M	M	L	L	L					M	M	H	L
CO3	H	M	M	H			L					H	M	H	L
CO4	H	H	M	H	M		H					M	M	H	L
CO5	H	H	H	M	L		L					L	M	H	L
16MPC404	H	H	M	M	L	L	M	L				M	M	H	L

L-Low, M-Moderate(Medium), H-High

16MPC405 METROLOGY AND MEASUREMENTS CATEGORY: PC

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MBS103 Applied physics

COURSE OBJECTIVES:

- *To acquire knowledge on various measuring instruments, measuring machines and principles of measurements of form, strain, force, torque, pressure, temperature and flow*

UNIT – I LINEAR AND ANGULAR MEASUREMENTS (9)

Length Standards - Length Measuring instruments - Vernier instruments - micrometer, height gauge, dial indicators, Bore gauges, Slip gauges, Comparators -Mechanical, Electrical, Optical & Pneumatic, Optical Projector. Angle measuring instruments - Bevel protractor, Sprit level, Sine bar, Autocollimator, Angle dekkor, Interferometry.

UNIT – II FORM MEASUREMENT (9)

Screw thread terminology- Measurement of effective diameter by two wire and three wire methods - errors in threads- Measurement of pitch, profile errors and total composite errors, Gear tooth terminology-Methods of measurements of runout, pitch, profile, lead, backlash, tooth thickness-composite method of inspection - Parkinson gear tester, Measurement of surface finish - Stylus probe instruments - profilometer-Tomlinson and Talysurf instrument-Straightness, Flatness and Roundness measurement.

UNIT – III MEASURING MACHINES AND ADVANCES IN METROLOGY (9)

Tool maker's microscope - Computer controlled CMM - Universal measuring machine - Automatic and multidimensional inspection machine - Computer aided inspection -Machine vision-Laser interferometer.

UNIT-IV MEASUREMENTS : STRAIN, FORCE, TORQUE AND PRESSURE MEASUREMENTS (9)

Electrical, Metallic Resistance Strain Gauge – Strain Gauge Ballast / Bridge circuit - Load cells - hydraulic and pneumatic systems - Pressure measuring transducers - Elastic and diaphragms – Mechanical, Hydraulic, Electric and Transmission Dynamometers.

UNIT - V TEMPERATURE, FLUID FLOW AND VIBRATION MEASUREMENTS (9)

Bi-Metallic strips - pressure thermometers, thermo couples, optical and radiation pyrometer - Flow measurement - Obstruction meters - Pitot tubes - Rotameters – Turbine type meters, magnetic flow meters - hot wire anemometer - vibrometers and accelerometers – seismic accelerometers.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

*1.Jain.R.K., **"Engineering Metrology",**Khanna Publishers, Delhi, 2004.*

*2.Thomas G. Beckwith, Roy D, Marangoni, John H.Lienhard V., **"Mechanical Measurements",** Addtion Wesley Publishing Company, 2004.*

REFERENCE BOOKS:

1. *Gupta. I.C**., "A text book of Engineering Metrology",**DhanpatRai& Sons, Delhi, 2003*
2. *Holman J P. , **"Experimental Methods for Engineers"** McGraw Hill Book Company, 2004*
3. *Jain R K**, "Mechanical and Industrial Measurements"**, Khanna Publishers, Delhi, 2004.*
4. *Charles Reginald Shotbolt, **"Metrology for Engineers",** 5th edition, Cengage Learning EMEA,1990.*
5. *Backwith, Marangoni, Lienhard, **"Mechanical Measurements"**, Pearson Education , 2006.*

COURSE OUTCOMES:

On completion of this course, students will be able to

***CO1:** Select and use appropriate measuring instruments for different applications.*

***CO 2**:Apply the knowledge of various measurement techniques for industrial needs.*

***CO 3:**Estimate mechanical and thermo physical properties*

***CO 4**:Apply the knowledge measurements in quality control*

***CO5**: Use advantage in metrology in quality control*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L	L	M			H						L	L	
CO2	H		M	H										M	
CO3		M	L	H									M	L	
CO4			M		M	H	L						M	M	
CO5		M				L					M		L	H	
16MPC405	L	L	L	M	L	L	L				L		L	M	

L-Low, M-Moderate(Medium), H-High

16MPC406 MANUFACTURING TECHNOLOGY II CATEGORY: PC

L	T	P	C
3	0	0	3

PREREQUISITES:

16MPC304 Manufacturing Technology I

COURSE OBJECTIVES:

* *To understand the mechanics of metal cutting, working of machine tools such as automats, major metal cutting processes and study the basics of nontraditional machining processes.*

UNIT – I THEORY OF METAL CUTTING (9)

Mechanism of metal cutting – types – cutting force – chip formation – Merchant's circle diagram – calculations – tool geometry – machinability – tool wear – tool life – cutting tool materials – cutting fluids – types.

UNIT – II AUTOMATS, SHAPING AND PLANING MACHINES (9)

Capstan and turret lathes – construction - indexing mechanism - operations - working principle of single and multi - spindle automats – shaping and planning machines – types – construction - mechanism – principle of operation – different shaping operations - work holding devices.

UNIT – III DRILLING, BROACHING AND GRINDING MACHINES (9)

Drilling machines – specifications, types - feed mechanism, operations – drill tool nomenclature – broaching – specifications, types, tool nomenclature, broaching operations – grinding – types of grinding machines – grinding wheels, specifications – bonds – mounting and reconditioning of grinding wheels.

UNIT – IV MILLING AND GEAR GENERATING MACHINES (9)

Milling – specifications – types - cutter nomenclature – types of cutters – milling processes – indexing – gear forming in milling – gear generation - gear shaping and gear hobbing – specifications - cutters –coated tools & inserts- cutting spur and helical gears - bevel gear generators – gear finishing methods.

UNIT – V NON-TRADITIONAL MACHINING (9)

Classification of machining processes - process selection - ultrasonic machining – abrasive jet machining – water jet machining - laser beam machining – electron beam machining – plasma arc machining.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1.Hajra Choudhry S.K. and Bose S.K., ***"Workshop Technology Vol II"****, Media Promoters and Publishers Pvt. Ltd., Bombay, 2004*

2. Sharma P.C., ***"A Text Book of Production Technology"****, S.Chand & Company Ltd., New Delhi, 10th Revised* edition*, 2010*

*3. P.N. Rao, "****Manufacturing Technology Foundry, Forming and Welding"****, Tata McGraw Hill 3rd Edition, 2009*

REFERENCE BOOKS

*1. Serope Kalpakjian and Steven R.Schmid, "****Manufacturing Engineering and Technology****", Addison Wesley Longman (Singapore) Pte Ltd, Delhi, 2009*

*2. Jain R.K. and Gupta S.C., "****Production Technology****", Khanna Publishers, New Delhi, 1999*

3. Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White ***"Machine Tool Practices"****, Prentice Hall of India, 1998*

4. Roy. A.Lindberg, ***"Process and Materials of Manufacture"****, Fourth Edition, PHI/Pearson Education 2006.*

COURSE OUTCOMES:

On *completion of this course, students will be able to*

CO 1: *Apply the theory of metal cutting in real life machining.*

CO 2*: Understand the operating mechanisms of lathe, shaping and planning machine.*

CO 3: *To gain knowledge on drilling, boring and grinding machines.*

CO 4*: Know about principles, operation and working of milling and gear generating machine.*

CO 5*: Non-traditional manufacturing methods.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1			M		H	L					M		M	M	
CO2	L	L	M	L	M										L
CO3		M				L								M	
CO4	L	M	L										M	M	
CO5	L				M								L	M	
16MPC406	L	L	L	L	L	L					L		L	M	L

L-Low, M-Moderate(Medium), H-High

16MPC407 MACHINE DRAWING AND DRAFTING LABORATORY CATEGORY:PC

L	T	P	C
0	0	4	2

PRE-REQUISITES:

* 16MES107 Engineering Graphics

COURSE OBJECTIVES:

To create knowledge about standard presentation of components and symbols. It develops the knowledge to select proper tolerance and fit levels of appropriate machine components. Induces the knowledge to generate about 2-dimensional and 3-dimensional drawing with Auto CAD

UNIT – I CONVENTIONS, ABBREVIATIONS, AND SYMBOLS (10)

Interrupted views, partial views of symmetrical objects, conventional representation of the continuous square and circular rod ends, adjacent parts, common machine elements, abbreviations, description of tolerances and grades, types of fits and their descriptions, selection of fits from standard tables- fits for different applications- examples- geometrical tolerances- surface finish conventions.

UNIT – II PREPARATION OF ASSEMBLY DRAWING (35)

Cotter joint, knuckle joint, flange coupling, universal coupling, footstep bearing, Plummer block, connecting rod end, screw jack, lathe tailstock, stop valves.

UNIT – III AUTOCAD (15)

Basic tools and commands of AutoCAD, line types, dimensioning, 2D drawing of machine components, 3D models, importing and exporting files to other software.

Lecture: 0 Periods Tutorial:0 Periods Practical:60 Periods Total:60 Periods

TEXT BOOKS:

1. *Gopalakrishna K.R., **"Machine Drawing"**, Subhas Publishers, Bangalore, 2003.*
2. *Bhatt.N.D, **"Machine Drawing"**, Chorotar Publishing House, 2001.*

REFERENCE BOOKS:

1. *Gill.P.S., "**Text Book of Machine Drawing"**, S.K. Kataria & Sons, Publishers & Distributors, Delhi, 1998.*
2. *Narayana K.L., Kanniah.P., Venkatareddy.K., **"Machine Drawing"**, New Age International Publishers, 2004.*
3. *James D. **"Engineering Graphics with AutoCAD 2002"**, Pearson Education, 2005.*
4. *Alan Kalameja, **"AutoCAD 2008: A tutor for Engineering Graphics",** Auto Desk Press 2007*

COURSE OUTCOMES:

Upon completion of the course, student will be able to

- ***CO1:*** *Ability to select proper joint for products design*
- ***CO2:*** *Ability to understand and initiate proper standards and codes*
- ***CO3****: Ability to use proper symbols and select proper tolerance values for appropriate applications*
- ***CO4:*** *Ability to communicate effectively in Industries (production line) through this subject knowledge*
- ***CO5****: Ability to develop the better drawing using Auto CAD software (blueprint) with full technical details as required*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M		L								H		H	L	
CO2	H							L			M		M		
CO3	L		H		L	M					M			M	L
CO4										H	L				L
CO5	L				H					M			M		
16MPC407	L		L		L	L		L		L	M		L	L	L

L-Low, M-Moderate(Medium), H-High

16MPC408 METALLURGY AND METROLOGY LABORATORY CATEGORY:PC

L	T	P	C
0	0	4	2

METALLURGY LABORATORY

PRE-REQUISITES:

16MBS103 Applied physics

16MPC305 Engineering Metallurgy

COURSE OBJECTIVES:

* *To provide practical knowledge of specimen preparation for micro examination, study the microstructures, defects of ferrous and nonferrous materials*

LIST OF EXERCISES

1. Study of Metallurgical microscope
2. Preparation of Specimen for metallographic examination
3. Preparation and Study of Microstructure of steel, cast iron and non ferrous alloys
4. Study of Microstructure of heat treated and untreated steels
5. Study of Microstructure of heat treated and untreated cast iron
6. Measurement of inclusion rating and grain size
7. Determination of hardenability of steel by Jominy end quench test
8. Study of Bravais lattices with the help of models
9. Study of microstructure of weldment and cast components
10. Study of Non destructive testing

Total: 30

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: *Demonstrate the specimen preparation methods.*

CO2: *Identify and analyze the microstructures and defects in ferrous and nonferrous engineering components*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	L	L	M	H	M	L	L	M	H	L	L	L	L	M	M
CO2	H	M	M	M	M	M	H	M	L	M	L	L	M	H	H
16MPC408	M	M	M	H	M	M	M	M	M	M	L	L	M	H	H

L-Low, M-Moderate(Medium), H-High

METROLOGY LABORATORY

COURSE OBJECTIVES:

- *To familiarize the basic concepts of measurements, various linear, angular and form measuring equipment, and their principles of operation.*

LIST OF EXPERIMENTS:

1. Study and use of Measuring Instruments.
2. Calibration of Dial gauge using Dial Calibration Tester.
3. Measurement of external taper angle using sine bar and slip gauges.
4. Measurement of internal and external dovetail angle using rollers.
5. Measurement of internal angle using spheres.
6. Measurement of external angle using rollers and slip gauges.
7. Measurement of spur gear tooth thickness using gear tooth vernier caliper.
8. Measurement of internal diameter and depth of the cylinder using spheres.
9. Measurement of effective diameter and pitch of screw thread using three wire method and pitch gauge.
10. Study of Autocollimator.
11. Study of Profile Projector.
12. Study of Tool Makers Microscope.
13. Study of Co-ordinate Measuring Machine.

Total: 30

Lecture: 0 Periods **Tutorial:0 Periods** **Practical:60 Periods** **Total:60 Periods**

REFERENCE BOOKS

1. Laboratory Manual prepared by Department of Production Engineering.

*2. Connie L Dotson, "**Fundamentals of Dimensional Metrology**", Cengage Learning (I) Private Limited, New Delhi, 2003.*

*3. Anand K Bewoor and Vinay A Kulkarni, "**Metrology and Measurement**", McGraw Hill Education (I) Private Limited, 2015.*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: *Explain the general concepts of measurements.*

CO2*: Perform some linear, angular and form measurements, and record observations.*

CO3*: Calibrate the measuring instruments.*

CO4: *Explain about various methods of traditional and modern measurements that are used in the industry to measure product dimensions.*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	L	L							M	L			L	M	
CO2	L	H							M	L			L	M	
CO3	L	H							M	L			M	L	
CO4	L	H			M				M	L			L	M	
16MPC408	L	H			L				M	L			L	M	

L-Low, M-Moderate(Medium), H-High

16MPC501 **DESIGN OF MACHINE ELEMENTS** **CATEGORY: PC**

(Use of Approved Design Data Book is permitted)

L	T	P	C
3	2	0	4

PRE-REQUISITES:

16MES206 Engineering Mechanics,
16MES302 Strength of Materials
16MPC407 Machine Drawing and Drafting Laboratory

COURSE OBJECTIVES:

- *To study proper materials for different machine elements depending on their physical and mechanical properties and gain knowledge about design of various machine elements used in equipments subjected to various types of stresses.*

UNIT – I BASICS OF DESIGN (9)

Basic procedure and requirements for designing machine elements - Stress-strain diagrams - Mechanical properties of engineering materials – preferred numbers, fits and tolerances – Modes of failure - Stresses in machine elements: Tension, Compression, Shear, bearing stress, Stress due to bending and eccentric axial loading - Principal stresses - Theories of elastic failure - Selection and use of failure theories.

UNIT – II FLUCTUATING STRESSES AND DESIGN OF SHAFT (9)

Stress concentration – Fluctuating Stresses - Fatigue failure - Endurance limit - low and high cycle fatigue – Notch Sensitivity - Reversed stresses (Design for finite and Infinite life) - Soderberg, Goodman and Gerber relations - Design of shaft under static and fatigue loading.

UNIT – III DESIGN OF ENERGY STORING ELEMENTS (9)

Design of helical, leaf and torsional springs - Design of flywheels considering stresses in rims and arms for engines and punching machines

UNIT – IV DESIGN OF TEMPORARY AND PERMANENT JOINTS (9)

Design of riveted, welded joints in plates and pressure vessels – design of eccentrically loaded riveted and welded joints – design bolted joints - design of joints with variable loading, adhesive joints.

UNIT – V MISCELLANEOUS ELEMENTS (9)

Design of rigid, flexible coupling and power screws – Design and selection of rolling and sliding contact bearing.

Lecture: 45 Periods **Tutorial:15 Periods** **Practical:0 Periods** **Total: 60 Periods**

TEXT BOOKS

1. *Shigley, J.E. and Mischke, C.R.,* ***"Mechanical Engineering Design"****, Tenth Edition, McGraw Hill International, 2014.*
2. *T.V. Sundarajamoorthy and N. Shanmugam,* ***"Machine Design"****, Khanna Publishers, 1998.*
3. *V.B. Bhandari,* ***"Design of Machine Elements"****, McGraw Hill Publication Co., 2014.*
4. ***"Design Data"*** *– P.S.G. College of Technology, Coimbatore.*

REFERENCE BOOKS

1. *U.C.Jindal,* ***"Machine Design"****, Pearson, 2010.*
2. *Juvinal, R.C.,* ***"Fundamentals of Machine Component Design"****, John Wiley, 2006.*
3. *Robert L Mott,* ***"Machine Elements in Mechanical Design"****, Pearson, 2013*
4. *Ugural A.C, "****Mechanical Design – An Integral Approach"*** *, McGraw-Hill Book Co,2004.*
5. *Dr. S. S. Wadhwa, Er. S. S. Jolly,* ***"Machine Design"****, Dhanpat Rai & Co, Delhi 2012.*

COURSE OUTCOME:

On completion of this course, students will be able to

CO1: *Understand the different types of stresses, materials properties and their significance in machine elements design*

CO2: *Design the shafts by considering failure theories for reliability*

CO3*: Design the energy storing elements for various applications according to the prescribed standards*

CO 4*: Design the temporary and permanent joints for fabrication of different machine components and boilers as per the standards*

CO 5: *Select couplings and bearings from standards for industrial applications*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		M	H		L						L		M	H	L
CO2		M	H	M						M			M	M	L
CO3		M	H		L								M	M	
CO4		M	H		L								M	H	
CO5		H	M							M			M	M	H
16MPC501		M	H	L	L					L	L		M	M	L

L-Low, M-Moderate(Medium), H-High

16MPC502 **THERMAL ENGINEERING** **CATEGORY: PC**

(Use of Approved Steam, Refrigeration and A/C Tables and Charts are Permitted)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC404 Engineering Thermodynamics

COURSE OBJECTIVES:

- *To provide exposure on thermodynamic cycles and to design thermal systems like IC engines, R&A/C systems and steam turbines*

UNIT – I THERMODYNAMIC CYCLES (9)

Air standard cycles – Otto, Diesel, Dual and Brayton cycles – air-standard efficiency – mean effective pressure – P-V and T-s diagrams.

UNIT - II I.C ENGINES (9)

I.C Engine - Actual cycles of 2 stroke and 4 stroke engines – valve and port timing diagrams. Fuel, ignition, cooling and lubrication system for spark ignition and compression ignition engines, Cetane and Octane rating of fuels – combustion, knocking and detonation, scavenging and supercharging – performance characteristics of I.C Engines.

UNIT – III AIR COMPRESSORS (9)

Reciprocating compressors – effect of clearance – multi stage – optimum intermediate pressure and perfect inter-cooling – rotary, centrifugal and axial flow compressors

UNIT – IV REFRIGERATION AND AIR CONDITIONING (9)

Air-refrigeration cycles, Simple vapour compression refrigeration cycle, Vapour compression refrigeration system – sub-cooling and super heating, vapour absorption system. Principles of psychometry – use of psychometric chart – principles of air-conditioning – types of air conditioning system – cooling load calculation.

UNIT – V STEAM NOZZLES AND TURBINES (9)

Flow through nozzles, shape of nozzle, effect of friction, critical pressure ratio and supersaturated flow. Impulse and reaction turbines – compounding, velocity diagrams for single stage turbines

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. Domkundwar and Kothandaraman, C.P, ***"Thermal Engineering",*** *Khanna Publishers, New Delhi 2010.*

2. Mahesh M Rathore ***"Thermal Engineering"****, McGraw Hill, New Delhi,2010.*

*3.Ganesan.V "****Internal Combustion Engines"****, Tata McGraw Hill, New Delhi,2010.*

REFERENCE BOOKS

1.Yunus Cengel, ***"Thermodynamics"*** *Tata McGraw Hill Company, 2010.*

*2. Nag. P.K., "****Engineering Thermodynamics"*** *, Tata McGraw Hill Company, 2010.*

3. Rajput, R.K. ***"Thermal Engineering"*** *Laxmi Publications (P) Ltd., 2010.*

4. Lewitt E.H. ***"Thermodynamics Applied to Heat Engines"*** *Pitman Engineering Degree Series,1965.*

5.Eastop.T.D, McConkey .A, ***"Applied Thermodynamics",*** *Pearson Education, 2010*

COURSE OUTCOMES:

On completion of this course, students will be able to

- ***CO 1****: Understand the functioning of thermodynamic cycles including actual cycles, P-V and T-S diagrams and VCR cycle*
- ***CO 2****: Utilize the understanding in designing and assess the performance of Internal Combustion engines*
- ***CO 3****: Make the thermal design and analysis for reciprocating air compressors with and without clearance.*
- ***CO 4****: Work on the vapour compression refrigeration system, air conditioning system and calculate cooling load estimation*
- ***CO 5:*** *Analyze the functioning of steam nozzle and steam turbines.*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M				H					M		L	M	
CO2							M			L			L		L
CO3	L		H						L	L	M		M		
CO4	M						M		M	L			M		H
CO5					M				M	L	L		M	H	
16MPC502	L	L	L		L	L	L		L	L	L		M	L	L

L-Low, M-Moderate(Medium), H-High

16MPC503 **DYNAMICS OF MACHINES** **CATEGORY:PC**

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MES206 Engineering Mechanics
16MPC403 Kinematics of Machines

COURSE OBJECTIVES:

- *To educate knowledge on Force analysis of machinery, balancing of rotating and reciprocating masses, Gyroscopes, Energy fluctuation in Machines. This forms the basics needed in the area of Mechanisms for Design courses in future.*
- *To understand the fundamentals of Vibration, Vibration analysis of engineering systems, its physical significance under desired conditions.*

UNIT – I FORCE ANALYSIS **(9)**

Static force and Dynamic force analysis of four bar mechanism, slider crank mechanism – Inertia force and inertia torque - D'Alemberts principle – Principle of superposition – turning moment diagrams – fly wheel.

UNIT – II BALANCING OF MASSES **(9)**

Concept of static and dynamic balancing – Analysis of unbalanced masses in rotating masses and reciprocating masses – single and multicylinder, V engines - graphical and analytical methods, Equipment for measurement of unbalanced masses

UNIT – III FREE VIBRATION **(9)**

Basic features of vibratory systems – degrees of freedom – free vibration – equations of motion – natural frequency – types of damping – damped vibration - critical speed of vibratory system – applications of critical speed concept - torsional systems:single, two rotor systems.

UNIT – IV FORCED VIBRATION **(9)**

Response to periodic forcing – harmonic forcing – unbalanced forcing - force transmissibility and amplitude transmissibility – vibration isolation.

Selection of vibration measuring instruments – accelerometer – dynamic properties and selection of structural materials for vibration control.

UNIT – V GOVERNING MECHANISM **(9)**

Governors – types – centrifugal governors – Porter governors – Proel and Hartnell Governors - characteristics – effect of friction – controlling force. Gyroscopes – gyroscopic forces and torques – gyroscopic stabilization – gyroscopic effects in automobiles, ships and airplanes.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

*1. Shigley J.E & J.J., **"Theory of Machines and Mechanisms"**, McGraw Hill Inc., 1995.*

*2. Rattan S.S**. "Theory of Machines"**, Tata McGraw Hill Publishing Co.Ltd, New Delhi, 2006.*

REFERENCE BOOKS

*1. Thomas Bevan, **"Theory of Machines"**, Pearson Education Limited, 2010*

*2. Ghosh A. and Mallick A.K., **"Theory of Mechanisms and Machines"**, Affiliated East-West Press Pvt.Ltd, 2000.*

*3.George H.Maritn, "**Kinematics and Dynamics of Machines",** Waveland PrInc,2002*

*4. R L Norton, **"Kinematics and Dynamics of Machinery"**, McGraw-Hill, 2009.*

*5. V.P.Singh, **"Mechanical Vibrations"**, Dhanapatrai & Sons, 2005*

COURSE OUTCOMES:

At the end of the course students will be able to

- ***CO1:*** *Perform the force analysis and develop the mechanical engineering systems.*
- ***CO2:*** *Identify and analyze unbalancing masses in machinery and equipments.*
- ***CO3:*** *Understand the vibrations in various mechanical systems and designing systems subjected to vibrations under desired conditions.*
- ***CO4:*** *Understand the influence of forced vibration and its control through measuring instruments.*
- ***CO5:*** *Understand the governing mechanism and gyroscopic principle.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	M	H	L	L	M	L	L	M	H	H	H
CO2	H	M	H	H	M	M	L	L	H	L	L	M	M	H	M
CO3	H	H	H	H	M	L	L	M	M	L	L	M	H	H	M
CO4	H	H	H	M	L	L	L	M	L	L	L	M	M	H	M
CO5	H	M	H	M	L	L	L	L	M	L	L	M	H	M	M
16MPC503	H	H	H	H	M	M	L	L	M	L	L	M	H	H	M

L-Low, M-Moderate(Medium), H-High

16MPC504 **TURBO MACHINES** **CATEGORY:PC**

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC306Fluid Mechanics and Machinery
16MPC404 Engineering Thermodynamics

COURSE OBJECTIVES:

* *To familiarize the basic flow equations and to acquire the knowledge for analyzing different turbo machines*.

UNIT - I INTRODUCTION TO TURBO MACHINES (9)

Classification of fluid machinery, Energy transfer between fluid and rotor, Dimensionless parameters-specific speed, affinity law, model law – applications - stage velocity triangles - work and efficiency.

UNIT - II CENTRIFUGAL BLOWER AND COMPRESSOR (9)

Types - stage, work, efficiency, h-s diagram and design parameters - flow analysis in impeller blades, diffusers, slip factor, losses and performance curves, fan drives and fan noise.

UNIT - III DESIGN OF IMPELLER AND VOLUTE (9)

Impeller layout, development of impeller profile - plan view, development of impeller end view, impeller inlet angles, development of impeller vane. Types of volute designs, single - volute casing designs, double - volute casing designs, double - volute dividing rib, triple - volute casings, quad - volute casing.

UNIT - IV AXIAL FLOW COMPRESSOR (9)

Stage velocity diagrams, enthalpy - entropy diagrams, stage losses and efficiency, work done factor, simple stage design, relation between angles and degree of reaction and performance characteristics.

UNIT - V RADIAL FLOW GAS TURBINES (9)

Inward Flow Radial Turbine(IFRT), ninety degree IFRT, Stage velocity diagrams, work done, reaction stages, losses and coefficients, blade testing and performance characteristics.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

*1. Yahya, S.M., "**Turbines, Compressors and Fans**"*, Tata McGraw Hill Publishing Company, 2010.

2. Val S Lobanoff, Robert R Ross, "**Centrifugal pumps – Design and applications",** Gulf Professional Publishing, 1992.

*3. Stepanoff, A.J.,**"Blowers and Pumps"**, John Wiley and Sons Inc. 1965.*

REFERENCE BOOKS

*1. Bruneck, **"Fans"**, PergamomPress, 1973.*

*2. Earl Logan, Jr., **"Hand book of Turbo Machinery"**, CRC Press., 2003.*

*3. Dixon, S.L., **"Fluid Mechanics and Thermodynamics of Turbo Machinery",** Butterworth-Heinemann,2005.*

4. HeinemanShepherd, D.G., "***Principles of Turbo Machinery"***, *Macmillan, 1969.*

5. Ganesan, V., "***Gas Turbines"***, *Tata McGraw Hill Pub. Co.,2010.*

COURSE OUTCOMES:

On completion of the course students will be able to

CO 1*: Apply the principle of turbo machines.*

CO 2*: Design and analyze the centrifugal machineries.*

CO3*: Design different types of volute and impeller.*

CO4*: Design and analyze the axial flow compressor.*

CO5*: Design and analyze the radial flow turbines.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	L	M	L	L					L		L	H	M
CO2	M	L	H	M	L	L					L		L	H	L
CO3	M	L	H	M	L	L					L		L	H	L
CO4	M	L	H	M	L	L					L		L	H	L
CO5	M	L	H	M	L	L					L		L	H	L
16MPC504	M	L	H	M	L	L					L		L	H	L

L-Low, M-Moderate(Medium), H-High

16MPC505 HYDRAULICS AND PNEUMATIC CONTROLS CATEGORY:PC

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC306 Fluid Mechanics and Machinery

COURSE OBJECTIVE:

* *To provide exposure to the basics of hydraulic and pneumatic principles and development of circuits for various engineering applications*

UNIT – I FLUID POWER SYSTEMS AND FUNDAMENTALS (9)

Introduction to fluid power - Advantages of fluid power - Application of fluid power system - Types of fluid power systems - Properties of hydraulic fluids – types of fluids – Fluid power symbols - Basics of hydraulics – Applications of Pascal's Law - Losses in pipe, valves and fittings - Pumping theory – Pump classification – Gear, Vane and piston pumps - construction and working of pumps – pump Selection.

UNIT – II CONTROL COMPONENTS, ACTUATORS (9)

Pressure, Flow and Directional control valves - Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, double acting special cylinders like tandem, Rod less, Telescopic - Cushioning mechanism - Construction of double acting cylinder - Rotary actuators - Gear, Vane and Piston motors.

UNIT – III DESIGN OF HYDRAULIC CIRCUITS (9)

Reciprocating- sequencing – synchronizing – regenerative – pump unloading – double pump circuits – Counterbalance valve application circuit - Accumulators circuits - Intensifier circuits – Fail - safe circuits.

UNIT – IV PNEUMATIC SYSTEMS AND COMPONENTS (9)

Properties of air – Compressors – Filter, Regulator, and Lubricator Unit – Air control valves, Quick exhaust valves, and pneumatic actuators - Control elements – position- pressure sensing – switching - Speed control circuits – Pneumo - hydraulic circuit - Sequential circuit design for simple applications using cascade method, step counter method - Selection of components for pneumatic systems.

UNIT – V SERVO SYSTEMS AND MAINTENANCE (9)

Servo systems – Hydro Mechanical servo systems - Electro hydraulic servo systems and proportional valves - Introduction to Electro Hydraulic/Pneumatic logic circuits, ladder diagrams - PLC applications in fluid power control - Fluid power circuits - installation and maintenance - failure and trouble shooting.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

*1. Anthony Esposito, **"Fluid Power with Applications"**, Pearson Education Inc. 2011*

*2. Majumdar S.R., **"Pneumatic systems – Principles and maintenance"**, Tata McGraw-Hill, 2006*

REFERENCE BOOKS:

*1. Michael J., Pinches and John G.Ashby, **"Power Hydraulics"**, Prentice Hall, 1989.*

*2. Lal, **"Oil hydraulics in the service of industry"**, Allied publishers, 1982.*

*3. James L. Johnson, **"Introduction to Fluid Power"**, Delmar/Thomson Learning,2003.*

*4. John J. Pippenger and Tyler G Hicks, **"Industrial Hydraulics"**, McGraw Hill Book Co., 1979.*

***5. "Industrial Hydraulics Manual"** 5 th Edition, Eaton Hydraulics Training Services, 2008.*

COURSE OUTCOMES:

At the end of the course students will be able to

- ***CO1:*** *Identify fluid power systems and select the appropriate pumps for industrial applications.*
- ***CO2****: Demonstrate the applicability of hydraulic power systems for engineering applications.*
- ***CO 3****: Design customized circuits in hydraulics for various industrial needs.*
- ***CO4****: Choose pneumatic systems and demonstrate the applicability of pneumatic power systems on real life applications.*
- ***CO 5****: Analyze failure of fluid power systems and to solve them.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	H	M	M	M		L					L		M		L
CO 2	M	M	M	M	L	M					L		L	L	L
CO 3	H	H	H	H	H	H	M				L	M	H	H	L
CO 4	H	H	M	M	L	M					L		L	L	L
CO 5	H	H	H	H	M	H	M				L		M	H	L
16MPC505	H	H	M	M	L	M	L				L	L	M	M	L

L-Low, M-Moderate(Medium), H-High

16MEE507 SKILL DEVELOPMENT PRACTICES CATEGORY:EEC

L	T	P	C
0	0	4	2

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

* To make students communicate effectively in different situations of professional career.

List of Experiments

1. Conversation with friends on day to day topics,
2. Consoling or advising for a situation
3. Attending Telephone calls (official)
4. Group discussion and debate.
5. Anchoring for a ceremony.
6. Conducting mock meetings.
7. Negotiate with supplier or customer.
8. Listen to any audio and speak about it.
9. Read a topic and speak about it.
10. PowerPoint presentation.
11. Conduct Interviews of different kinds (one to one, many to one, telephonic interview) .
12. Aptitude testing on given topic

Lecture: 0 Periods Tutorial:0 Periods Practical:60 Periods Total:60 Periods

COURSE OUTCOMES

On completion of this course the student will be able to

CO 1: *Converse freely with neighbors and colleagues to maintain good relationship.*

CO 2: *Discuss issues in a group for effective planning and execution.*

CO 3: *Prepare for a speech by reading or listening to audio.*

CO 4: *Do presentations in a group using modern aids.*

CO 5: *Select right personal for the concern through interviews.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1								L	M	H	L	L		L	M
CO2						L	L	M	M	H	L	L	L	L	H
CO3								L	L	H	L	L			
CO4					L		L		M	H		H	M		
CO5						L		M	M	H		H		L	
16MEE507					L	L	L	L	M	H	L	M	L	L	L

L-Low, M-Moderate(Medium), H-High

16MPC508 THERMAL ENGINEERING LABORATORY I CATEGORY:PC

L	T	P	C
0	0	4	2

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

* *To conduct performance tests on I.C engines, compressors and blowers*

LIST OF EXPERIMENTS

1. Valve timing and port timing diagrams of single cylinder diesel engines.
2. Performance test on 4 stroke Diesel Engine.
3. Heat balance test on 4 stroke Diesel Engine.
4. Retardation test to find Frictional Power of a Diesel Engine.
5. Economic speed test on Diesel Engine.
6. Performance test on Constant speed blower.
7. Performance test on Variable speed blower.
8. Performance test on Reciprocating Air compressor.
9. Performance test on four stroke computerized diesel engine.
10. Emission test on Internal Combustion engine

Lecture: 0 Periods Tutorial:0 Periods Practical:60 Periods Total:60 Periods

COURSE OUTCOMES:

On completion of this course, students will be able to

***CO 1**: Select the suitable thermal devices for the specified industrial applications.*

***CO 2**: Evaluate the performance of I.C engines.*

***CO 3**: Conduct experiments on compressors and blowers.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	M		L		M	H	L	M	L			L	L	M
CO2	M	H	M	H	M	L	H		L	L			L	M	
CO3	L	M	M			L			M	L		L		L	L
16MPC508	L	M	L	L	L	L	M	L	M	L		L	L	L	L

L-Low, M-Moderate(Medium), H-High

16MPC509 MANUFACTURING TECHNOLOGY LABORATORY CATEGORY:PC

L	T	P	C
0	0	4	2

PRE-REQUISITES:

16MPC304 Manufacturing technology I
16MPC406 Manufacturing technology II

COURSE OBJECTIVES:

- *To practice operations in lathe, radial drilling, shaper, grinder, milling machine and gear cutting (gear hobbing, gear shaping and milling) and CNC machines.*

LIST OF EXERCISES

1. Facing, plain turning, step turning, Taper turning and parting
2. Groove cutting, knurling and chamfering.
3. Thread cutting (Internal and external -Vee and square)
4. Drilling and counter sinking
5. Drilling, reaming, tapping and surface grinding using surface grinder and Radial drilling machine.
6. External cylindrical grinding of shaft.
7. V-Groove cutting in shaping machine.
8. Spur gear milling.
9. Helical gear milling.
10. Gear shaping.
11. Gear hobbing.
12. Making hexagonal hole using slotting machine.
13. Letter cutting in vertical milling machine.
14. Machining – turning, drilling using CNC machining centre.

Lecture: 0 Periods Tutorial:0 Periods Practical:60 Periods Total:60 Periods

COURSE OUTCOMES:

On completion of this course, students will be able to

***CO 1**: Operate machines tools for various assembly and fabrication tasks and expose to time management.*

***CO 2:** Prepare gears using forming and generating methods of gear manufacturing and CNC operation.*

***CO 3**: To set up machines like lathe shaper, grinding and milling machine for various applications.*

***CO 4:** Fabricate parts for equipments / tools used for project works.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M				L		L			L		L		L	
CO2		L							L	M			H		L
CO3		M			M		L	L				M		M	
CO4			H				M	M		H			H		L
CO5	H	H			M			M						H	
16MPC509	L	L	L		L		L	L	L	L		L	L	L	L

L-Low, M-Moderate(Medium), H-High

16MPC601 COMPUTER AIDED DESIGN AND MANUFACTURING CATEGORY:PC

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MES107 Engineering Graphics
16MPC406 Manufacturing Technology II

COURSE OBJECTIVES:

* *To expose the basics of computer based modeling, principles of part programming process planning and product data management.*

UNIT – I INTRODUCTION (09)

Evolution of CAD/CAM and CIM – segments of generic CIM – Flexible Manufacturing System (FMS). Computers and workstation, elements of interactive graphics, input / output devices – programmable logic controllers (PLC) – logic ladder program – applications of PLC in CNC- robotics – CAD - 2D graphics: clipping - line drawing algorithm (Mid point algorithm only) – 2D and 3D translation, rotation and scaling.

UNIT – II GEOMETRIC MODELING (09)

Design process – CAD process – wireframe, surface, solid modeling – b-rep, constructive solid geometry – surface of revolution, swept surfaces, ruled and developed surfaces, Bezier and B - Spline curves and surfaces – engineering analysis – design review and evaluation, automated drafting – CAD software.

UNIT – III NC, CNC AND DNC (09)

Numerical control - classifications – point-to-point, straight cut and contouring – positioning – incremental and absolute systems – driving devices – feed back devices – NC part programming – manual programming for simple components – computer aided part programming- Introduction to Automatically Programmed Tools (APT) programming – programming with interactive graphics – computer automated part programming.

UNIT – IV COMPUTER AIDED SHOP FLOOR CONTROL (09)

Introduction to group technology, part classification and coding, production flow analysis, cellular manufacturing systems – computer aided material handling system – computer aided process planning – variant and generative process planning methods – artificial intelligence in process planning.

UNIT – V PRODUCT AND PRODUCTION MANAGEMENT (09)

Introduction to product data management (PDM) – CAD integration in product data management - PDES – Computer aided production management system (CAPMS) – Computer monitoring and control system. Case study on computer assisted production management.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

*1. Mikell P.Groover**, "Automation, Production Systems and Computer-Integrated Manufacturing**", Pearson Education, New Delhi, 2016.*

*2. P. Radhakrishnan and S. Subramanyan **"CAD/CAM/CIM**" New Age International(P) Ltd, New Delhi , 2009.*

*3. Zeid, **"Mastering CAD/CAM"**, McGraw Hill International Edition, 2016.*

REFERENCE BOOKS

*1. Mikell P. Groover and Enory W. Zimmers Jr. **"CAD/CAM: Computer Aided Design and Manufacturing**," Prentice Hall of India, New Delhi.2005.*

*2. David Bedworth, **"Computer Integrated Design and Manufacturing"**, TMH, New Delhi, 1998.*

*3. Zeid Ibrahim, **"CAD/CAM Theory and Practices",** McGraw Hill International Edition,2013.*

*4. P. Radhakrishnan and S. Subramanyan **"CAD/CAM/CIM"** Willey Eastern Limited, New Delhi, 2009.*

*5. Donald Hearn and M.Pauline Baker, **"Computer Graphics"** Prentice Hall Inc., 2002.*

COURSE OUTCOMES:

On completion of this course, students will be able to

***CO 1**: Appreciate the importance of computers and modern tools in design and manufacturing to reduce cost and matching the societal needs.*

***CO 2:** Create and analyze 2D and 3D models using CAD modeling software.*

***CO 3**: Develop programs for CNC machine tools and CIM / FMS for a manufacturing unit prepare part programs,*

***CO 4:** Apply knowledge on CAPP, and apply computer aided process planning techniques*

***CO 5:** To monitor and control shop floor with the aid of computers*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1			H								M				
CO2	L	L	M	L	L									M	
CO3														M	
CO4	L	L	L										M	M	
CO5	L				M								L	M	
16MPC601	L	L	L	L	L						L		L	M	

L-Low, M-Moderate(Medium), H-High

16MPC602 **OPERATIONS RESEARCH** **CATEGORY:PC**

(Use of Approved Statistical Tables Permitted)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MBS3Z1 Engineering Mathematics III

COURSE OBJECTIVES:

- *To acquire knowledge of linear programming and network problems and their solving techniques. To develop the skill of resolving queing situations and comprehend decision strategies.*

UNIT - I LINEAR MODELS (9)

Phases and characteristics of operation research study – graphical method – simplex algorithm – duality – dual simplex method. Solution by Excel solver.

UNIT - II NETWORK MODELS (9)

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

UNIT - III INVENTORY, TRANSPORTATION AND ASSIGNMENT MODELS (9)

Inventory models – economic order quantity models – safety stock – reorder point – lead time – quantity discount models – transportation problems – assignment problems.

UNIT - IV QUEUING THEORY (9)

Queuing models – queuing systems and structures – notation parameter – single server and multi server models – poisson arrival – exponential service – simulation – Monte Carlo technique – use of random numbers.

UNIT -V DECISION MODELS (9)

Decision models – game theory – two person zero sum games – graphic solution – replacement models – replacement policies - models based on service life – economic life.

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS

*1. Sharma, S.D, **"Operations Research**", kedarNath Ram Nath & Co. Meerut, 1994.*

*2. P.K. Gupta & D.S. Hira, **"Problems in Operations Research** (Principles & Solutions)", S.Chand & Co. Ltd., 2003.*

*3. Taha Hamdy A, **"Operations Research"**, Prentice Hall of India Pvt. Ltd., 1997.*

REFERENCE BOOKS

*1. Dharani Venkatakrishnan. S,**"Operations Research"** (Principles & Problems), Keerthi Publishing House Pvt. Ltd., 1996.*

*2. Don. T. Phillips, Ravindren, A and James Solberg**," Operations Research"**, John Wiley & Sons, 1987.*

*3. Fourer, D.Gay and B. Kernighan, AMPL, **"A Modeling Language for Mathematical Programme"**, Brook s/Cole-Thomson, 2003.*

COURSE OUTCOMES:

Upon completion of the course, student will be able to

***CO 1:** Understand the use of linear programming problems and methods of solving*

***CO 2:** Evaluate optimal routes with minimum distance and maximal flow capacity so as to reduce cost.*

***CO 3**: Apply economic order quantity concept to minimize inventory carrying charges.*

***CO 4:** Analyse queing situations thereby reduce waiting time of costumers and make effective system utilization.*

***CO 5:** Make strategic decisions.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	L	H					L	L	L	L	L	M
CO2	H	M	M	L	L					L	L	M	L	L	M
CO3	H	H	H	M	L					L	M	L	L	L	M
CO4	H	L	M	M	L					L	L	M	L	L	M
CO5	H	M	M	M	L				H	L	L	H	L	L	M
16MPC602	H	M	M	M	L				L	L	L	M	L	L	M

L-Low, M-Moderate(Medium), H-High

16MPC603 **DESIGN OF TRANSMISSION SYSTEMS** **CATEGORY:PC**

(Use of Approved Design Data Book is permitted)

L	T	P	C
3	2	0	4

PRE-REQUISITES:

16MES206 Engineering Mechanics
16MPC403 Kinematics of Machines
16MPC501 Design of Machine Elements

COURSE OBJECTIVES:

* *To study power transmitting and power controlling elements*

UNIT - I DESIGN OF POWER TRANSMISSION ELEMENTS (9)

Selection of ropes, Flat belt – V belt – ribbed V belt – selection of chains and sprockets – Ratchet and pawl mechanism.

UNIT - II SPUR AND HELICAL GEARS (9)

Kinematics – force analysis in gears – stress analysis – dynamic effects – gear blank design - estimating gear size, module and face width - power rating calculations based on strength and wear considerations, crossed helical gear terminology - estimating the size of the pair of crossed-helical gears.

UNIT - III BEVEL AND WORM GEAR (9)

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth, estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits – Terminology. Thermal Capacity, Materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

UNIT - IV DESIGN OF GEAR BOX (9)

Geometric progression - standard step ratio - ray diagram, kinematic layout - design of sliding mesh and constant mesh gear box - introduction to planetary gear box.

UNIT - V FRICTION CLUTCHES AND ENGINE COMPONENTS (9)

Design of plate clutches – axial clutches - cone clutches - internal expanding rim clutches. Design of piston, connecting rod and crank shaft.

Lecture: 45 Periods **Tutorial: 30 Periods** **Practical: 0 Periods** **Total: 75 Periods**

TEXT BOOKS

*1.Joseph Edward Shigley and Charles, R. Mischke, **"Mechanical Engineering Design"**, McGraw Hill International ,2014.*

*2. V.B. Bhandari, **"Design of Machine Elements"**, McGraw Hill Publication Co., 2014.*

*3. T.V. Sundarajamoorthy and N. Shanmugam, **"Machine Design"**, Khanna Publishers, 1998.*

*4. **"Design Data"** – P.S.G. College of Technology, Coimbatore.*

REFERENCE BOOKS

1. *Gitin M. Maitra and L.V. Prasad,* ***"Hand Book of Mechanical Design"****, II Edition, Tata McGraw Hill,1995.*
2. *Juvinal R.C.* ***"Fundamentals of Machine Components Design"*** *John Wiely and Sons. 2011*
3. *Merhyle F.Spotts,Terry E.Shoup and Lee E.Hornberger* ***"Design of Machine elements"****, Prentice Hall, India International ed, 2003.*
4. *Robert L Mott,* ***"Machine Elements in Mechanical Design"****, Pearson, 2013*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1: *Select flexible transmission elements for machinery and equipments.*

CO 2: *Understand kinematics of gears and can design spur and helical gears for engineering use.*

CO 3*: Understand kinematics of gears and can design bevel and worm gears for engineering use.*

CO 4*: Design and develop gear box for various machinery and equipments.*

CO 5*: Design friction clutches and engine components.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		H	M	L	L								H	M	
CO2	L	H		L	M						L		M	H	L
CO3	L	H		L	M						L		M	H	L
CO4		M	H	L	L								M	H	
CO5		M	H	L	L								M	H	
16MPC603	L	H	M	L	L						L		M	H	L

L-Low, M-Moderate(Medium), H-High

16MPC604 **HEAT AND MASS TRANSFER** **CATEGORY: PC**

(Use of Approved Heat and Mass Transfer Data Book is permitted)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MBS2Z2 Engineering Mathematics-II

16MPC404 Engineering Thermodynamics

COURSE OBJECTIVES:

* *To familiarize and appreciate different modes of heat and mass transfer and its applications*

UNIT - I CONDUCTION (9)

Fundamental differential equation of heat conduction in Cartesian coordinates- representation of general heat conduction equation in cylindrical and spherical coordinates – Fourier's law of heat conduction – boundary and initial conditions – plane wall and radial systems – critical thickness of insulation – conduction with thermal energy generation – heat transfer from extended surfaces – transient heat conduction.

UNIT - II CONVECTION (9)

Principles of convection – convection boundary layer – laminar and turbulent flow – empirical relations for external and internal forced convection flows – flat plate, cylinders, spheres – empirical relations for free convection flows – horizontal cylinders, horizontal plates, vertical planes, inclined surfaces and enclosed spaces.

UNIT - III RADIATION (9)

Nature of thermal radiation – radiation intensity – relation to emission, irradiation and radiosity – black body radiation – loss of radiation – emissivity – surface emission – Kirchhoff's law – gray surface – view factor – radiation exchange between black surfaces – radiation exchange between gray surfaces – electrical analogy – radiation shields.

UNIT - IV HEAT EXCHANGERS (9)

Types – overall heat transfer coefficient – fouling factor – heat exchanger analysis using log mean temperature difference (LMTD) and effectiveness – number of transfer units (NTU) method – compact heat exchangers, methodology of heat exchanger design calculations.

UNIT - V MASS TRANSFER (9)

Introduction – concentration , velocities, fluxes – mechanisms of diffusion, diffusion in a stationary and moving medium – mass convection – analogy between convective heat and mass transfer – simultaneous heat and mass transfer.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1.Sachdeva R.C., ***"Fundamentals of Engineering Heat and Mass Transfer"****, New Age International Publishers, New Delhi, 2010.*

2. Kothandaraman C.P., ***"Fundamentals of Heat and Mass Transfer"****, New Age International Publishers, New Delhi, 2010*

REFERENCE BOOKS:

1. Frank P Incropera and David P. Dewitt, ***"Fundamentals of Engineering Heat and Mass Transfer",*** *John Wiley and Sons, 2010*

2. Holman J.P., ***"Heat and Mass Transfer"****, Tata Mc Graw Hill, 2010*

3. Yadav R., ***"Heat and Mass Transfer"****, Central Publishing House, Allahabad, 2010*

4. Ozisik M.N., ***"Heat Transfer",*** *McGraw Hill Book Co., 2005*

5. Yunus Cengel, ***"Heat Transfer"****, McGraw Hill Company, 2008.*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1*: Apply the concepts of heat transfer in conduction mode to real problems.*

CO 2: *Apply the concepts of heat transfer in convection mode to engineering applications.*

CO 3*: Apply the concepts of radiation heat transfer in practical problems.*

CO 4*: Design and analyze the heat exchanger components.*

CO 5*: Apply the mass transfer in real life problems.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	M	H	M	M	L					L		L	H	L
CO2	L	M	H	M	M	L					L		L	H	L
CO3	L	M	H	M	M	L					L		L	H	L
CO4	L	M	H	M	M	L					L		L	H	L
CO5	L	M	H	M	M	L					L		L	H	L
16MPC604	L	M	H	M	M	L					L		L	H	L

L-Low, M-Moderate(Medium), H-High

16MPC607 THERMAL ENGINEERING LABORATORY II CATEGORY: PC

	L	T	P	C
PRE-REQUISITE	0	0	4	2

16MPC502 Thermal Engineering

COURSE OBJECTIVES:

**To provide exposure to the students on studying the performance of heat transfer equipments*

LIST OF EXPERIMENTS

1. Test on pin fin apparatus.
2. Test on counter flow heat-exchanger.
3. Determination of convection heat transfer coefficient.
4. Determination of thermal resistance and conductivity.
5. Determination of emissivity of non-black surfaces.
6. Determination of transient temperature distribution.
7. Performance test on cooling tower.
8. Determination of COP of a heat pump.
9. Determination of COP of a refrigeration system.
10. Determination of COP of an air-conditioning system.
11. Study of Boiler, steam turbine and Steam Engines.

Lecture: 0 Periods Tutorial:0 Periods Practical:60 Periods Total:60 Periods

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1 : *Conduct of experiments on heat transfer*

CO 2 *: Estimate COP of refrigerator, heat pump and air-conditioning system.*

CO 3 *: Illustrate the working of boiler, steam turbines and steam engines.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L			M	L	H	H		H	L	L	M
CO2	M	M	L	L			H	L	H	H		M	L	L	M
CO3	H	L	L	M		L	M		M	M		M	L	L	L
16MPC607	M	M	L	L		L	M	L	H	H		M	L	L	M

L-Low, M-Moderate(Medium), H-High

16MPC608 DYNAMICS AND INSTRUMENTATION LABORATORY CATEGORY:PC

L	T	P	C
0	0	4	2

PRE-REQUISITES:

16MPC503 Dynamics of Machinery

COURSE OBJECTIVES:

- *To acquire knowledge on the dynamic conditions of machines. To develop the skill of measuring techniques and calibrating measuring instruments*

LIST OF EXPERIMENTS

DYNAMICS:

1. Governors – determination of sensitivity, effort, etc. for Watt, Porter, Proell, Hartnell governors.
2. Drawing profile of the cam.
3. Motorized Gyroscope – verification of laws – determination of gyroscopic couple.
4. Whirling of shaft – determination of critical speed of shaft.
5. Balancing of reciprocating masses and Balancing of rotating masses.
6. Vibration system – spring mass system – determination of damping co-efficient of single degree of freedom system.
7. Determination of torsional frequencies for compound pendulum and flywheel system with lumped Moment of inertia.
8. System identification using dynamic response curves.

INSTRUMENTATION:

1. Calibration of Pressure gauges.
2. Calibration of Vacuum gauges.
3. Calibration of Thermometers and Thermocouples.
4. Determination of Flash point and Fire point.
5. Determination of Viscosity – Red Wood Viscometer.
6. Determination of Viscosity – Saybolt Viscometer.
7. Calibration of Rota meter.
8. Calibration of Tachometer.
9. Determination of Calorific Value of Fuels.

Lecture: 0 Periods Tutorial:0 Periods Practical:60 Periods Total:60 Periods

COURSE OUTCOMES:

Upon completion of the course, student will be able to

***CO 1** : Understand the dynamic behavior of high speed machines.*

***CO 2**: Evaluate unbalanced forces and necessary counter measures in rotating and reciprocating machines.*

***CO 3**: Understand measuring methods of different process parameters and calibrating techniques of measuring instruments.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	H	M	L	L		L	L		H	L	M	L
CO2	H	M	M	H	M	L	L		L	L		M	L	M	L
CO3	H	M	M	H	L	L	L		L	L		M	L	M	L
16MPC608	H	M	M	H	M	L	L		L	L		M	L	M	L

L-Low, M-Moderate(Medium), H-High

16MEE609 **MINI PROJECT** **CATEGORY:EE**

L	T	P	C
0	0	8	4

COURSE OBJECTIVES:

- *Opportunity to design and develop small working models.*
- *Develop experimental or simulation solutions to small industrial problems.*
- *Facilitate problem identification, formulation and solution.*
- *Work collaboratively in small groups.*

The students may be grouped into groups of about four members per group and work under a project supervisor. The device / system / component(s) to be fabricated / investigated / analyzed may be decided in consultation with the supervisor. An industrial expert may be included as an external supervisor. A project report to be submitted by the group and the fabricated model / investigation / analysis to be reviewed and evaluated continuously by a committee constituted by the head of the department / program coordinator.

Lecture: 0 Periods **Tutorial:0 Periods** **Practical:240 Periods** **Total: 120 Periods**

COURSE OUTCOMES:

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

CO1: *Model or simulate solutions to small engineering problems considering environmental issues*

CO2: *Apply the principles of mechanical engineering to solve engineering problems*

CO3: *Perform feasibility study and manage activities to complete task in specified duration.*

CO4: *Assign and undertake tasks in a team as per team discussion.*

CO5: *Do presentation and write technical reports for effective communication within and outside the team.*

COURSE ARTICULATION MATRIX

CO/ PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	H	H	H	H	M	H	H	L	H	-	M	-	H	H	H
CO2	H	H	H	H	M	H	H	-	H	-	L	-	H	H	-
CO3	M	M	M	M	M	L	L	L	H	L	M	H	H	H	-
CO4	H	M	M	L	L	L	M	H	H	H	-	H	H	H	-
CO5	-	-	-	-	M	M	-	L	H	H	-	M	H	-	H
16MEE609	M	M	M	M	M	M	M	M	H	L	L	M	H	M	M

L – Low, M – Moderate (Medium), H - High

16MHS701 ENGINEERING ECONOMICS AND MANAGEMENT CATEGORY:HS

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

* *Prepare engineering students to systematically manage people and other resources while scientifically analyzing economic conditions to take sound marketing and product decisions*.

UNIT - I INDUSTRIAL ECONOMICS (9)

Economics - Wealth, Welfare, Scarcity definitions, Demand - Law, Exceptions to the Law, Factors influencing demand, Elasticity – types, influencing factors, Supply- Law, Factors influencing supply, Elasticity, Cost concepts - cost and output relationship in the short and long run.

UNIT - II MONEY BANKING AND TRADE (9)

Money - (Barter to e-banking) Evolution, Functions, Limitations – Inflation - Types, Causes, Methods to correct inflation, Impact, Deflation - Methods to correct deflation, Impact, Functions of commercial banks and Reserve Bank - An introduction to International Monetary institutions.

UNIT - III PRINCIPLES OF MANAGEMENT (9)

Evolution of Management thought - Functions of Management – Planning - Process, Types, Organizing - Formal and informal organization, Line and Staff authority, Delegation of authority, Staffing - Systems approach, Directing - Leadership, Motivation, Communication, Controlling - Process, Techniques.

UNIT - IV FINANCIAL MANAGEMENT (9)

Concept and Definition - Purpose of investment - Types of capital - Sources of Finance - Financial statements - Stock exchange - Cash flow statements - Break even analysis.

UNIT - V MARKET MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR (9)

Sales and market management - Management of sales – Advertisement - Market research - Sales Forecasting. Organizational Behaviour - Individual behavior – Personality, Perception, Group behavior - Group formation and group dynamics

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

*1. Ahuja,H.L., "**Managerial Economics",** S.Chand Publishing, New Delhi, 2009.*

*2. Bhusan Y.K., "**Fundamentals of Business Organization and Management",** Sultan Chand and Sons, New Delhi, 2001.*

*3. Pillai,R.S.N., Bagavathi, **"Modern Marketing- Principles and Practices",** S.Chand and Company Private Limited, New Delhi,2009.*

REFERENCE BOOKS

*1.Harold Koontz, Heinz Weihrich, "**Essentials of Management",** McGraw Hill, 2003.*

*2.Sundharam K.P.M., "**Money, Banking and International Trade",** Sultan Chand Sons, New Delhi, Reprint 2002.*

*3.Fred Luthans, "**Organizational Behaviour",** Tata McGraw Hill, Singapore 2006.*

*4.Robbins S.P., Timothy A.Judge, "**Organizational Behaviour",** Pearson., New Delhi, 2015.*

COURSE OUTCOMES:

CO1: *Able to analyze the prevailing market conditions and ensure scientific forecasting of demand and supply thereby reducing wastes in production.*

CO2: *Able to evaluate the intent and outcomes of government stabilization policies designed to correct macroeconomic problems.*

CO3: *Able to work as an effective team player utilizing the knowledge of functions of management.*

CO4: *Effectively and objectively analyze the financial challenges based on the concepts such as time value of money and budgeting of scarce resources.*

CO5: *Able to effectively manage the intricacies of diversity of individuals in organizations.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1						L	M					H	M	M	
CO2							M						M		
CO3									H			H			M
CO4											M			M	
CO5									H	H					H
16MHS701						L	L		L	L	L	L	L	L	L

L-Low, M-Moderate(Medium), H-High

16MPC702 **FINITE ELEMENT ANALYSIS** **CATEGORY:PC**

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MBS1Z2 Engineering Mathematics I
16MBS401 Numerical Methods
16MES302 Strength of Materials
16MPC604 Heat and Mass transfer

COURSE OBJECTIVES:

- *To acquire knowledge of computational techniques of solving problems in multiphysics. To develop the skill of solving problems with complex boundaries.*

UNIT - I RELEVANCE OF FEM **(9)**

Historical background - basic concept of FEM – discretization of 1D, 2D and 3D Domains, mesh refinement, convergence requirements - gradient and divergence theorems - boundary and initial value problems

UNIT - II CHARACTERISTIC MATRICES AND LOAD VECTORS **(9)**

One dimensional governing equations - structural and heat transfer problems - variational method-variation calculus – weighted residual methods – Galerkin method - Ritz method - generalized coordinate's approach - principle of minimization of potential energy.

UNIT - III ONE DIMENSIONAL PROBLEMS **(9)**

Derivation of shape functions, Stiffness matrices and force vectors - Assembly of Matrices - shape function characteristics - problems in axial load members, trusses, heat transfer through composite walls and fins - Gauss elimination and Cholesky's methods of solving equations. Solving through computer codes.

UNIT - IV TWO DIMENSIONAL PROBLEMS **(9)**

Derivation of shape functions for CST and LST triangular and rectangular elements, Stiffness matrices and force vectors - Pascal's triangle - concept of plane stress and plain strain and axi-symmetry - Structural and heat transfer application - introduction to coupled field analysis.

UNIT - V HIGHER ORDER ELEMENTS **(9)**

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Jacobian transformation - Serendipity and Lagrangian elements – Numerical integration - Matrix solution techniques.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Larry J. Segerlind* ***, "Applied Finite element Analysis"****, John Wiley & Sons , 1987*

*2. Logan D L****, "A First Course in the Finite Element Method"****, Third Edition, Thomson Learning, 2002.*

REFERENCE BOOKS:

1. Singiresu.S.Rao, ***"The Finite Element Method in Engineering"****, ButterWorth Heinemann, 2001.*

2. J.N Reddy, ***"An Introduction to Finite Element Method"****, McGraw Hill, Intl, Student Edition 2003.*

*3. Tirupathi R. Chandrupatla and Ashok D. Belegundu****, "Introduction to Finite Element in Engineering"****, Pearson Education ,2003*

4. David V.Hutton, ***"Fundamentals of finite element Analysis",*** *McGraw Hill Inc, Newyork, 2004.*

*5. J Seshu. P,****"Textbook of Finite Element Analysis",*** *Prentice Hall of India, 2003.*

COURSE OUTCOMES:

Upon completion of the course, student will be able to

- ***CO1:*** *Understand the applications of numerical methods and their advantages.*
- ***CO2:*** *Evaluate complexities in solving boundary value problems and effective solving methods.*
- ***CO3****: Apply numerical techniques to solve structural and heat transfer problems.*
- ***CO4****: Analyse two dimensional problems in mechanical engineering.*
- ***CO5:*** *Use higher order elements to obtain more accurate solutions.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	M	M	L					L		L	M	M	L
CO2	H	L	M	H	L					L	L	L	M	M	L
CO3	H	M	M	H	H		L			L	L	L	M	M	L
CO4	M	H	M	M	L		L			L	M	L	M	M	L
CO5	M	M	M	M	L					L		L	M	M	L
16MPC702	H	M	M	M	L		L			L	L	L	M	M	L

L-Low, M-Moderate(Medium), H-High

16MEE707 **SIMULATION LABORATORY** **CATEGORY:EEC**

L	T	P	C
0	0	4	2

PRE-REQUISITES:

16MES302 Strength of Materials
16MPC501 Design of Machine Elements

COURSE OBJECTIVES:

* *To learn to develop geometric models and to use finite element modeling for simulating various engineering applications.*

COURSE CONTENT:

1. Modeling and Meshing.
2. Solution and Post processing.
3. Various types of Analysis: Structural, Thermal and coupled field analysis
   - Stress analysis of an axisymmetric component
   - Stress analysis of a plate with hole and rectangular bracket
   - Stress analysis of plane strain problems
   - Stress analysis of three dimensional components
   - Thermal analysis of fins, composite walls, chimneys and weld assembly
   - Modal analysis of Beams
4. Introduction to ANSYS Parametric Design Language.

Lecture: 0 Periods **Tutorial:0 Periods** **Practical:60 Periods** **Total:60 Periods**

COURSE OUTCOME:

On completion of this course the student will be able to

CO1: *Understand the use of simulation software to solve problems in mechanical engineering.*

CO2: *Interpret complex engineering structures or machine parts by finite element simulation.*

CO3: *Simulate multi-physics problems.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	M		H	L			L		L		L	L	L
CO2	M	L	M		H	L			L		L		L	L	L
CO3	M	L	M	H	H	L			L		L		L	L	L
16MEE707	M	L	M	L	H	L			L		L		L	L	L

L-Low, M-Moderate(Medium), H-High

16MEE708 **CAD /CAM LABORATORY** **CATEGORY:EEC**

L	T	P	C
0	0	4	2

PRE-REQUISITES:

16MES107 Engineering graphics
16MPC407 Machine drawing and drafting Laboratory
16MPC304 Manufacturing Technology I
16MPC406 Manufacturing Technology II
16MPC601 Computer Aided Design and Manufacturing

COURSE OBJECTIVES:

* *To study the usage of CAD software packages for assembly building and to develop part programs codlings on a CNC machines for various part*

COMPUTER AIDED DESIGN (CAD)

1. Sketching - create, edit and dimension the sketch, constraints, datum planes, construction aids.
2. 3D Part modeling – protrusion, cut, sweep, draft, loft, blend, rib.
3. Editing – move, pattern, mirror, round, chamfer.
4. Assembly - creating assembly from parts - assembly constraints.
5. Conversion of 3D solid model to 2D drawing - different views, sections, isometric view and dimensioning.
6. Introduction to surface modeling.
7. Introduction to File Import, Export – DXF, IGES, STL, STEP formats.
8. 3D modeling of machine elements like flanged coupling, screw jack etc.

Any of the 3D MODELING software likes Pro/E, IDEAS, CATIA and UNIGRAPHICS to be used.

COMPUTER AIDED MANUFACTURING (CAM)

MANUAL PART PROGRAMMING (Using G and M Codes) in CNC lathe

1. Part programming for linear and circular interpolation, chamfering and grooving
2. Part programming using standard canned cycles for turning, facing, taper turning and thread cutting.

MANUAL PART PROGRAMMING (using G and M codes) in CNC milling

1. Part programming for linear and circular interpolation and contour motions.
2. Part programming involving canned cycles for drilling, peck drilling, and boring.

SIMULATION AND NC CODE GENERATION USING CAM PACKAGE

1. NC code generation using CAD / CAM softwares (EDGECAM) - post processing for standard CNC Controllers like FANUC, Sinumeric etc.

Lecture: 0 Periods **Tutorial:0 Periods** **Practical:60 Periods** **Total:60 Periods**

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: *Develop and create models of different mechanical system using CAD packages and its tools.*

CO2: *Familiarize to use different modeling tools and import export files in different formats.*

CO3: *Generate coding from the part drawings and feeding in the machine to simulate execute part program in CNC machine*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	H	H	H	M	L						L	L	
CO2	H	H	M	H	H	H			L					L	L
CO3	H	H	H	M	M	L							L	L	
16MEE708	H	H	H	H	H	M	L		L				L	L	L

L-Low, M-Moderate(Medium), H-High

16MEE801 **PROJECT** **CATEGORY:EE**

L	T	P	C
0	0	16	8

COURSE OBJECTIVES:

- *Opportunity to apply the knowledge learned throughout the program.*
- *Undertake problem identification, formulation and solution.*
- *Facilitate technical, project management and presentation spheres.*
- *Work cooperatively in small team environment.*

The students may be grouped into groups of about four members per group and work under a project supervisor. The device / system / component(s) to be fabricated / investigated / analyzed may be decided in consultation with the supervisor. An industrial expert may be included as an external supervisor. A project report to be submitted by the group and the fabricated model / investigation / analysis to be reviewed and evaluated continuously by a committee constituted by the head of the department / program coordinator.

Lecture: 0 Periods **Tutorial:0 Periods** **Practical:240 Periods** **Total: 240 Periods**

COURSE OUTCOMES:

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

CO1: *Model or simulate solutions to small engineering problems considering environmental issues*

CO2: *Apply the principles of mechanical engineering to solve engineering problems*

CO3: *Perform feasibility study and manage activities to complete task in specified duration.*

CO4: *Assign and undertake tasks in a team as per team discussion.*

CO5: *Do presentation and write technical reports for effective communication within and outside the team.*

CO6: *Update with latest technology and behave ethically*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	M	H	H	L	H	-	M	-	H	H	H
CO2	H	H	H	H	M	H	H	-	H	-	L	-	H	H	-
CO3	M	M	M	M	M	L	L	L	H	L	M	H	H	H	-
CO4	H	M	M	L	L	L	M	H	H	H	-	H	H	H	-
CO5	-	-	-	-	M	M	-	L	H	H	-	M	H	-	H
CO6	L	L	H	L	H	H	L	H	-	L	H	L	H	-	H
16MEE801	M	M	M	M	M	M	M	M	H	M	L	M	H	M	M

L – Low, M – Moderate (Medium), H - High

16MPEX01 REFRIGERATION AND AIR CONDITIONING CATEGORY:PE

(Use of Approved Refrigeration and Air conditioning Tables and Charts are Permitted)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC404 Engineering Thermodynamics
16MPC502 Thermal Engineering
16MPC604 Heat and mass transfer

COURSE OBJECTIVES:

* *To study different refrigeration systems used in households, industries and development of air conditioning systems based on cooling load*

UNIT - I REFRIGERATION CYCLES AND REFRIGERANTS (9)

Air refrigeration cycles – reversed Carnot cycle, Bell Coleman cycle, simple vapour compression refrigeration cycle, compound compression refrigeration cycles, and cascade refrigeration cycles.

UNIT - II VAPOUR ABSORPTION AND OTHER SYSTEMS (9)

Ammonia – water system, Lithium Bromide – water system - Electrolux refrigeration system, Steam jet refrigeration and solar refrigeration systems. Refrigerants – properties and classification – eco friendly refrigerants

UNIT - III SYSTEM COMPONENTS (9)

compressors – reciprocating, rotary and centrifugal compressors, evaporators- flooded, dry expansion, shell and tube and double pipe evaporators, condensers – air cooled, water cooled and evaporative condensers, expansion devices – automatic, capillary tube and thermostatic expansion valve.

UNIT - IV DUCT DESIGN AND DISTRIBUTION (9)

Air distribution systems – study of different types of duct systems, methods of duct design, duct insulation, air purity – air cleaning methods.

UNIT - V AIR CONDITIONING AND COOLING LOAD (9)

Psychrometry, psychrometer, psychometric processes, moist air behaviour, effective temperatures, sensible heat factor ratio and cooling load estimation for an air conditioned space.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. *Arora S C and Domkundwar S., **"Refrigeration and Airconditioning"**, DhanpatRai & Sons 8th Edition,, New Delhi, 1997.*
2. *Roy J Dossat, **" Principle of Refrigeration"**, Wiley Eastern Limited, Fifth Edition 2001.*

REFERENCE BOOKS

1. *Stocker, **"Refrigeration and Air Conditioning"**, Tata McGraw Hill Publishing Company Limited, New Delhi 1982.*
2. *Manohar Prasad, **"Refrigeration and Air Conditioning"**, Wiley Eastern Limited, 2004.*
3. *Jordan and Prister, **"Refrigeration and Air Conditioning"**, Prentice Hall of India Limited, NewDelhi, 1985.*
4. *Arora C.P, **"Refrigeration and Air Conditioning"**, Tata McGraw Hill Publishing Company Limited, 3rd Edition, NewDelhi, 2009.*
5. *P.N. Ananthanarayanan, **"Basic Refrigeration and Air Conditioning",** Tata McGraw Hill Publishing Company Limited, 4th Edition, 2013.*

COURSE OUTCOMES

On completion of this course, students will be able to

- ***CO1**: Work on various refrigeration cycles*
- ***CO2:** Work on various refrigeration systems operated using heat energy*
- ***CO 3**: Design refrigeration components.*
- ***CO 4**: Design air distribution systems.*
- ***CO 5**: Estimate cooling load for air conditioning.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M		L			L	M				L		L	L	L
CO2	M		L			L	M				L		L	L	L
CO3	M	M	L			L	M				L		L	L	L
CO4	M	M	L			L	M				L		L	L	L
CO5	M		L			L	M				L		L	L	L
16MPEX01	M	L	L			L	M				L		L	L	L

L-Low, M-Moderate(Medium), H-High

16MPEX02 MANUFACTURING PLANNING AND CONTROL CATEGORY:PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC406 Manufacturing Technology II
16MHS701 Engineering Economics and Management

COURSE OBJECTIVE:

* *To know the concepts of manufacturing, planning and the activities in production planning and control in an industry*

UNIT – I WORK STUDY AND ERGONOMICS (9)

Method study – basic procedure - steps in method study, recording, selection and recording techniques – micro motion and memo motion study – techniques of work measurement - time study – production study - work sampling - ergonomics.

UNIT - II PLANT LOCATION (9)

Objective and subjective factors – break even analysis – single facility location problem – multi facility location problems – model for warehouse location problem - facility location model – Brown and Gibson model.

UNIT - III PLANT LAYOUT AND MATERIAL HANDLING (9)

Introduction – classification of layout – layout design procedures – CRAFT, ALDEP and CORELAP - Materials Handling – unit load concept – material handling principles – classification of material handling equipments.

UNIT - IV PRODUCTION PLANNING (9)

Demand forecasting - time series forecasting models - Delphi method of forecasting -forecast errors – Material resource planning (MRP) and Enterprise resource planning (ERP).

UNIT - V PRODUCTION CONTROL (9)

Functions of production control - product design and analysis – process planning and design – value analysis – standardization – simplification and specialization – make or buy decisions – Inventory control - need for inventory - Inventory cost, Inventory turns-purchase order model - economic order quantity - model with and without shortages – simple problems in determination of EOQ.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Samuel Eilon, **"Elements of Production Planning and Control"**, Universal Book Corporation, 1993.*
2. *Panneerselvam, R., **"Production and Operations Management"**, 2nd edition, Prentice Hall of India, New Delhi, 2012.*

REFERENCE BOOKS

1. *Barnes, "**Motion and Time study**", John Wiley, New York, 1990.*
2. *Apple, J.M. "**Plant Layout and Materials Handling**", Ronald Press Company, NewYork, 1977.*
3. *Buffa, E.S., "**Modern Production/Operations Management**", 7th edition, John Wiley sons, 1983.*
4. *Scheele Evan D, "**Principles & Design of Production Control Systems**", Prentice Hall Inc.,1962.*
5. *Norman Gaither G. Frazier, "**Operations Management**", Thomson Learning, 9th Edition IE, 2007.*

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: *Identify the method of time measurement in industries.*

CO2: *Choose the appropriate type of plant location and layout.*

CO3: *Select the suitable material handling techniques for customized applications.*

CO4: *Apply manufacturing planning in industry needs.*

CO5: *Implement and analyze the manufacturing control in strategic industry.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L		L	L	L	L				L		M	L	L
CO2	M	M	L	L	L	M	H				L	L	M	M	L
CO3	M	L	M	L	L	M	M				L	L	M	M	L
CO4	M	L		L	M	L	L				L		M	M	L
CO5	H	H	H	H	H	H	M				L		M	M	L
16MPEX02	M	M	L	M	M	M	M				L	L	M	M	L

L-Low, M-Moderate(Medium), H-High

16MPEX03 **POWER PLANT ENGINEERING** **CATEGORY:PE**

(Common to Production Engineering)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC502 Thermal Engineering

COURSE OBJECTIVES:

- *To learn the economics of power generation.*
- *To understand the working of power plants and its comparative analysis.*

UNIT - I ECONOMICS OF POWER GENERATION (9)

Load and load duration curves. Electricity billing – costing of electrical energy – Tariff structures. Economics of power plant – Fixed and variable cost. Payback period. Net Present Value, Internal Rate of Return. Emission calculation and carbon credit.

UNIT - II HYDRO POWER PLANTS (9)

Energy scenario – Global and National. Essential elements and classification of hydro power plants. Typical Layout and associated components. Selection of turbines. Pumped storage plants.

UNIT - III THERMAL AND GAS TURBINE POWER PLANTS (9)

Cycle analysis - Layout of modern coal based power plant. Super Critical Boilers - FBC Boilers. Subsystems – Water and Steam, Fuel and ash handling, Air and Gas, Draught system. Diesel and Gas Turbine power plants- Layout and Functioning. Environmental impact and Control.

UNIT - IV NUCLEAR POWER PLANTS (9)

Layout and subsystems. Fuels and Nuclear reactions. Boiling Water Reactor, Pressurized Water Reactor, Fast Breeder Reactor, Gas Cooled and Liquid Metal Cooled Reactors – working and Comparison. Safety measures. Environmental aspects.

UNIT - V RENEWABLE ENERGY POWER PLANTS (9)

Solar power plants – Photovoltaic and Thermal. Wind power plants – Vertical and Horizontal axes Wind Turbines. Biomass power plants – Gasification and combustion. Tidal and Ocean Thermal Energy plants. Geothermal plants. Fuel cell – Types. Hybrid power plants.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *G.R. Nagpal, **"Power Plant Engineering"**, Khanna publishers, 2012.*
2. *S.C. Arora and S. Domkundwar, **"A Course in Power Plant Engineering"**, Dhanpat Rai and sons, 2014.*

REFERENCE BOOKS

1. *P.K.Nag,* ***"Power Plant Engineering"****, Tata McGraw Hill, 2014.*
2. *Paul Breeze,* ***"Power Generation Technologies"****, Elsevier Ltd., 2014.*
3. *M.M.El.Wakil,* ***"Power Plant Technology"****, Tata McGraw Hill, 2010.*
4. *R.K. Rajput,* ***"A Textbook of Power Plant Engineering"****, Laxmi Publications pvt ltd, 2016.*
5. *James Momoh,* ***Smart Grids - Fundamentals of Design and analysis****, Wiley Press, 2012.*

COURSE OUTCOMES:

On completion of this course, Learners will be able to

CO 1: *Arrive at cost of power generation, electricity billing and rate of return on power plant investments*

CO 2*: Understand the working of Hydro-electric power plants.*

CO 3:*Analyze the working of Conventional power plants such as Thermal and Gas Turbines.*

CO 4*:Understand the working of nuclear power plants and its functional components.*

CO 5*:Understand the different types of renewable energy systems and its functional components*.

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	H	M	H	L	M	L	L	L	M	H	M	H	M
CO2	L	M	H	L	M	L	H	M	M	L	H	L	L	H	H
CO3	M	M	H	M	M	H	M	L	L	H	M	M	H	H	L
CO4	H	M	L	M	H	M	L	M	L	H	H	M	M	H	H
CO5	M	L	L	H	M	M	L	H	H	M	H	H	M	H	M
16MPEX03	M	M	M	M	M	M	M	M	M	M	H	M	M	H	M

L-Low, M-Moderate(Medium), H-High

16MPEX04 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS CATEGORY:PE

(Use of Approved Data book is permitted)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC304 Manufacturing Technology I
16MPC406 Manufacturing Technology II
16MPC501 Design of Machine Elements

COURSE OBJECTIVES:

- *To understand the concepts of press tool design and fixture design for machining and forming systems.*

UNIT - I LOCATING AND CLAMPING PRINCIPLES (9)

Tool design objectives - tool design in manufacturing - planning the design - principles of supporting and locating elements - referencing, basic rules of locating - planes of movement - locating from a flat surface - locating from internal and external diameter - external profile - ejectors - principles of clamping and work holding – types - non mechanical clamping - clamping accessories - materials used in jigs and fixtures.

UNIT - II DESIGN OF JIGS (9)

Drill bushes – different types of jigs – plate, latch, channel, box, angle plate, post, turnover, pot jigs - Automatic drill jigs - Rack and pinion operated, air operated jigs - design and development of jigs for simple components.

UNIT - III DESIGN OF FIXTURES (9)

General principles of milling boring, lathe and broaching fixtures - Grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures- modular fixtures - design and development of fixtures for simple component – quick change fixtures.

UNIT - IV PRESS ELEMENTS AND CUTTING DIE DESIGN (9)

Press working terminology – types - presses and accessories - tonnage requirements - strip lay out calculations - shearing action - die and punch elements - strippers, knockouts, stops, pilots, selection of standard die sets - design and development of progressive and compound dies for blanking and piercing operations.

UNIT - V DESIGN OF FORMING AND MISCELLANEOUS DIES (9)

Design and development of forming - bending and drawing dies - types - design considerations in forging - extrusion – recent trends in tool design – introduction to computer aids for sheet metal forming analysis.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. *Kempster, "**Jigs and Fixtures Design**", The English Language Book Society, 1998.*
2. *Joshi P.H, "**Jigs and Fixtures**", Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.*

REFERENCE BOOKS

1. *Donaldson C, "**Tool Design**", Tata McGraw-Hill, New Delhi, 2003.*
2. *K.Venkataraman, "**Design of Jigs, Fixtures & Press tools**", Tata McGraw-Hill Publishing Company Limited, New Delhi 2005.*
3. *Edward G Hoffman, "**Jigs and Fixture Design**", Thomson – Delmar Learning, Singapore, 2004.*
4. *Hiram E Grant, "**Jigs and Fixture**" Tata McGraw Hill, New Delhi, 2003.*
5. *"**Fundamentals of Tool Design**", CEEE Edition, ASTME, 1983.*

COURSE OUTCOMES

On completion of this course, students will be able to

***CO 1**: Design appropriate clamping and locating systems for specific operations.*

***CO 2**: Apply the concepts of jigs design for simple components.*

***CO 3**: Apply the concepts of fixture design for simple components.*

***CO 4:** Apply the concepts of die design for shearing operations.*

***CO 5:** Apply the concepts of die design for forming operations*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	M	H		L				L		L		L	L	L
CO2	L	M	H		L				L		L		L	L	L
CO3	L	M	H		L				L		L		L	L	L
CO4	L	M	H		L				L		L		L	L	L
CO5	L	M	H		L				L		L		L	L	L
16MPEX04	L	M	H		L				L		L		L	L	L

L-Low, M-Moderate(Medium), H-High

16MPEX05 DESIGN FOR MANUFACTURE CATEGORY:PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC304 Manufacturing Technology I
16MPC406 Manufacturing Technology II
16MHS2Z4 Environmental Science and Engineering

COURSE OBJECTIVES:

- *To create knowledge about the design factors which are influencing the manufacturing process*
- *To select proper manufacturing process with the environment concerns*

UNIT - I DESIGN PRINCIPLES FOR MANUFACTURABILITY (9)

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, process capability - feature tolerances geometric tolerances - assembly limits - datum features - tolerance stacks.

UNIT - II FACTORS INFLUENCING FORM DESIGN (9)

Working principle, material, manufacture, design- possible solutions - materials choice - the influence of materials on form design - form design of welded members, forgings and castings.

UNIT - III COMPONENT DESIGN - MACHINING (9)

Design features to facilitate machining - drills - milling cutters - keyways - doweling procedures, countersunk screws - a reduction of the machined area- simplification by separation - simplification by amalgamation - design for machinability - design for the economy - design for clampability - design for accessibility - design for assembly.

UNIT – IV COMPONENT DESIGN - CASTING (9)

Redesign of castings based on parting line considerations - minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - modifying the design - group technology.

UNIT - V DESIGN FOR ENVIRONMENT (9)

Introduction – environmental objectives – global issues – regional and local issues – basic dfe methods – design guidelines – life cycle assessment method – techniques to reduce environmental impact – design for energy efficiency – design to regulations and standards.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. *Robert Matousek, **" Engineering Design- A systematic approach"**, Blackie&sons ltd., 1963*
2. *Harry Peck, **"Design for Manufacture"**, Pitman Publishers, 1983.*

REFERENCE BOOKS

1. *David M. Anderson,* ***"Design for Manufacturability: How to Use Concurrent Engineering to Rapidly Develop Low-Cost, High-Quality Products for Lean Production"****, CRC Press Taylor & Francis Group, Suite, 2014.*
2. *Boothroyd, G, "****Design for Assembly Automation and Product Design",*** *New York, Marcel Dekker. 1980*
3. *Bralla, "****Design for Manufacture handbook"****, McGraw-hill, 1999.*
4. *Carrado Poli,,* ***"Design for Manufacturing: A structured Approach"****, Butterworth Heinemann, 2001.*
5. *O.Molloy, S. Tilley, and E.A. Warman,* ***"Design for Manufacturing and Assembly: Concepts, Architectures and Implementation"****, Chapman & Hall, 1998.*

COURSE OUTCOMES:

Upon completion of the course, student will be able to

- ***CO 1.*** *Ability to select appropriate manufacturing process for different components*
- ***CO 2.*** *Able to select the correct design factors for manufacturing process*
- ***CO 3.*** *Able to implement the economic design for manufacturing and assembly processes*
- ***CO 4.*** *Able to redesign the manufacturing process as per new Product production with the knowledge of group technology*
- ***CO 5.*** *Ability to select exact manufacturing methods with the concern of environmental factors*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	M								L		L	M	
CO2		M									L		M		
CO3									L		M			L	
CO4			H	L										L	
CO5	L						M						L		
16MPEX05	L	L	L	L			L		L		L		L	L	

L-Low, M-Moderate(Medium), H-High

16MPEX06 **MECHATRONICS** **CATEGORY:PE**

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MES402 Applied electronics and microprocessor
16MPC505 Hydraulics and Pneumatic controls

COURSE OBJECTIVES:

* *To study the mechatronics system and understanding the concepts of integration and design of mechatronics system.*

UNIT – I SYSTEM MODELS (9)

Introduction to mechatronics – components of mechatronic systems - measurement systems – open loop and closed loop control systems - basic system models-mathematical models - mechanical system building blocks – electrical system building blocks - Fluid system building blocks.

UNIT – II SENSORS AND ACTUATION SYSTEMS (9)

Introduction – performance terminology – displacement - position - proximity – velocity and motion – fluid pressure – temperature sensors – light sensors – selection of sensors. Hydraulic systems and pneumatic actuators – Directional control valves - rotary actuators – Mechanical actuation systems – Cams – Gear Trains – Ratchet and pawl - Belt and Chain Drives – Bearings - Electrical Actuation Systems.

UNIT – III SIGNAL CONDITIONING (9)

Signal conditioning processes - Operational amplifier – protection – conversion – filtering – wheat stone bridge - digital signal conditioning

UNIT – IV CONTROLLERS (9)

Introduction - control modes - PD, PI, PID Controllers - digital controllers- adaptive control system - Programmable logic controller – basic structure – input /output processing – programming - mnemonics – timers – internal relays and counters – data handling – analog input/output - selection of PLC.

UNIT – V DESIGN OF MECHATRONICS SYSTEMS (9)

Stages in designing mechatronics systems – traditional and mechatronics design – case studies of mechatronics systems – pick and place robot – automatic car park system – engine management system - automatic washing machine

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *W.Bolton, **"Mechatronics"**, Longman,2nd Edition,1999*
2. *S. Ramachandran, A. Sivasubramanian**"Mechatronics"**, Air Walk Publication, 2004.*

REFERENCE BOOKS

1. *Michael B. Histand and David G.Alciatore, **"Introduction to Mechatronics and Measurement Systems"**, Tata McGraw Hill, 2nd Edition,2003*
2. *D.A.Bradley,D.Dawson,N.C.Buru and A.J.Loader**, "Mechatronics"** Chapman and Hall,1993*
3. *Dan Necsulescu, **"Mechatronics"**,Pearson Education Asia,2005*
4. *Devdas Shetly, Richard A. Kolk, **"Mechatronics System Design"**, Thomson, PWS publishing co, 2007.*
5. *Smaili.A and Mrad.F, **"Mechatronics integrated technologies for intelligent machines",** Oxforduniversity press, 2008*

COURSE OUTCOMES:

At the end of the course students will be able to

***CO1**:Identify the key elements of mechatronics system and models.*

***CO2**: Select appropriate Sensors and actuators for industrial application.*

***CO 3**: Design and analyze the system for various signal outputs.*

***CO 4**: Integrate mechanical, electrical, electronics, control systems in the mechatronics system design.*

***CO 5**: Design, build, interface the elements for mechatronics system.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M	L	H	L	L	H	L	M	L	M	H	L
CO2	H	H	H	L	L	H	L	L	M	L	M	L	M	H	L
CO3	H	H	H	L	L	H	L	L	M	L	M	L	M	H	L
CO4	H	H	H	M	H	H	L	L	M	M	L	L	H	H	L
CO5	H	H	H	M	L	H	L	L	H	M	M	M	H	H	L
16MPEX06	H	H	H	H	L	H	L	L	M	L	M	L	M	H	L

L-Low, M-Moderate(Medium), H-High

16MPEX07 COMPUTATIONAL FLUID DYNAMICS CATEGORY:PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC306 Fluid Mechanics and Machinery

16MPC604 Heat and Mass Transfer

16MPC702 Finite Element Analysis

COURSE OBJECTIVES:

- *To expose the students to the basics of CFD and its procedures*

UNIT - I FLUID DYNAMICS AND GOVERNING EQUATIONS (9)

Basic fluid dynamics equations, Equations in general orthogonal coordinate system – Continuity, Momentum and Energy equations – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour - Elliptic, Parabolic and Hyperbolic equations.

UNIT – II FINITE DIFFERENCE METHOD (9)

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes.

UNIT – III FINITE VOLUME METHOD (FVM) FOR CONDUCTION (9)

Finite volume formulation for steady state one and two - dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes

UNIT – IV FINITE VOLUME METHOD FOR CONVECTION (9)

Steady one-dimensional convection– Central, upwind differences schemes-properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT – V CALCULATION FLOW FIELD BY FVM (9)

Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, two equation (k-Є) models.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. *T.J. Chung*, "***Computational Fluid Dynamics"***, *Cambridge University, Press, 2002*.
2. *Ghoshdastidar , P.S.,* "***Computer Simulation of flow and heat transfer"***, *Tata McGraw Hill Publishing Company Ltd., 1998.*

REFERENCE BOOKS

1. *Versteeg, H.K., and Malalasekera, W.,* "***An Introduction to Computational Fluid Dynamics: The finite volume Method"***, *Longman, 1998*.
2. *Patankar, S.V.* "***Numerical Heat Transfer and Fluid Flow"***, *Hemisphere Publishing Corporation, 2004.*
3. *Muralidhar, K., and Sundararajan, T.,* "***Computational Fluid Flow and Heat Transfer"***, *Narosa Publishing House, NewDelhi, 1995.*
4. *Pradip Niyogi, Chakrabarty .S.K., Laha .M.K."* ***Introduction to Computational Fluid Dynamics"***, *Pearson Education, 2005.*
5. *Anil W. Date,* "***Introduction to Computational Fluid Dynamics"***, *Cambridge University Press, 2005.*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1: *Apply the concept of governing equations in simulation problems.*

CO 2*: Apply the finite difference method for flow simulation.*

CO 3*: Apply finite volume method for steady and transient heat conduction problems.*

CO 4: *Apply finite volume method for convection heat transfer problems.*

CO 5*: Apply the finite volume method for fluid flow problems.*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	M	M	M			L		L		M	L	H	M
CO2	H	H	M	M	L	L			L	L	L	M	L	H	L
CO3	H	H	M	H	L				L	L	L	H	L	H	L
CO4	H	M	M	M	L				L	L	L	M	L	H	L
CO5	H	M	M	H	L				L	L	L	M	L	H	L
16MPEX07	H	M	M	M	L	L		L	L	L	L	M	L	H	L

L-Low, M-Moderate(Medium), H-High

16MPEX08 DESIGN OF ROTATING MACHINERY CATEGORY:PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC502 Thermal Engineering
16MPC501 Design of Machine Elements
16MPC603 Design of Transmission Systems

COURSE OBJECTIVE:

* *To impart knowledge of the integrated design procedure of rotating machinery and its elements.*

UNIT - I BASICS OF PUMP DESIGN (9)

System analysis for pump selection, specific speed and modeling laws, impeller design, general pump design, volute design- types, universal volute sections, casing shrinkage. Design of multi stage casing, double suction pumps and side suction pump

UNIT - II MECHANICAL DESIGN OF PUMP (9)

Shaft design, shaft sizing based on peak torsional stress, shaft sizing based on fatigue evaluation. Shaft deflection, key stress, axial thrust for double suction single stage pumps, single suction single stage overhung pumps and multi stage pumps.

UNIT - III STEAM TURBINE SYSTEM (9)

Mechanical drive steam turbines, casing design, steam admission sections, journal bearings for industrial turbo machinery, thrust bearings for turbo machinery, active magnetic bearings.

UNIT - IV TURBINE ROTOR (9)

Rotors for impulse turbines – long term operating experience, built-up construction, solid construction, turbine rotor balance methods, balance tolerance. Rotors for reaction turbines- solid rotors, welded rotor design, materials for rotors.

UNIT - V ROTOR DYNAMICS (9)

Dynamic stiffness, effects of damping on critical speed prediction, bearing-related developments, impedance, partial arc forces, rotor response, sub synchronous vibration, rotor stability criteria, SAFE diagram - evaluation tool for packeted bladed disk assembly, interference diagram beyond N/2 limit.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. *Heinz P. Bloch, Murari P. Singh "**Steam Turbines-Design, Applications, and Rerating"** The McGraw-Hill Companies, 2009.*
2. *Val S Lobanoff, Robert R Ross"**Centrifugal pumps – Design and applications"** Gulf Professional Publishing, 1992.*

REFERENCE BOOKS

1. *Norton L. R., "**Machine Design – An Integrated Approach**" Pearson Education, 2000.*
2. *Shigley, J.E., "**Mechanical Engineering Design**", McGraw Hill, 1986.*
3. *R. K. Turton, "**Rotodynamic Pump Design"** CambridgeUniversity Press, 2004.*
4. *Shepherd, D.G.,"**Principles of Turbo machinery"**, Macmillan, 1969.*
5. *Stepanoff, A.J., **Blowers and Pumps**, John Wiley and Sons Inc. 1965.*

COURSE OUTCOMES:

On completion of the course students will be able to

***CO1**: Design and analyze the volute for different type of applications.*

***CO2**: Design and analyze the shaft for different type of pumps.*

***CO3**: Design and analyze the different casing and bearing for steam turbine.*

***CO4**: Design the different types of turbine rotors.*

***CO5**: Analyze the turbine rotor stability.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	H	H	L	L					L		L	H	L
CO2	L	L	H	H	L	L					L		L	H	L
CO3	L	L	H	H	L	L					L		L	H	L
CO4	L	L	H	H	L	L					L		L	H	L
CO5	L	L	H	H	L	L					L		L	H	L
16MPEX08	L	L	H	H	L	L					L		L	H	L

L-Low, M-Moderate(Medium), H-High

16MPEX09 **GAS DYNAMICS AND JET PROPULSION** **CATEGORY:PE**

(Use of Standard Gas Tables permitted)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC404 Engineering Thermodynamics
16MPC306 Fluid Mechanics and Machinery

COURSE OBJECTIVES:

* *To impart knowledge on behaviour of compressible flow and propulsion systems*

UNIT - I BASIC CONCEPTS AND ISENTROPIC FLOWS (9)

Energy and momentum equations of compressible fluid flows - Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers

UNIT - II FLOW THROUGH DUCTS (9)

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – Friction Choking and Its Consequences, variation of flow properties.

UNIT - III NORMAL AND OBLIQUE SHOCKS (9)

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl Meyer Flow around Concave and Convex Corners, Prandtl – Meyer relations – Applications.

UNIT - IV JET PROPULSION (9)

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, and turbofan and turbo prop engines.

UNIT - V SPACE PROPULSION (9)

Types of rocket engines – Propellants - feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity - Applications – space flights.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Anderson, J.D., "**Modern Compressible flow**", 3rd Edition, McGraw Hill, 2003.*
2. *Yahya, S.M. "**Fundamentals of Compressible Flow with aircraft and rocket propulsion**", New Age International (P) Limited, New Delhi, 2016.*

REFERENCE BOOKS

1. *Hill. P. and C. Peterson, "**Mechanics and Thermodynamics of Propulsion**", Addison – Wesley Publishing company, 1992.*
2. *Zucrow. N.J., "**Aircraft and Missile Propulsion**", Vol.1 & II, John Wiley, 1975.*
3. *Zucrow. N.J., "**Principles of Jet Propulsion and Gas Turbines**", John Wiley, New York, 1970.*
4. *E.Rathakrishnan., "**Gas Dynamics**" Prentice Hall of India private limited, 2012.*
5. *V.Babu., "**Fundamentals of Gas Dynamics**" Athena Academic Ltd, UK, 2015.*

COURSE OUTCOMES

On completion of the course students will be able to

CO1: *Apply the concepts of isentropic flow in practical applications.*

CO2: *Analyze the flow phenomena in ducts.*

CO3: *Identify and analyze the normal and oblique shocks.*

CO4: *Design the jet propulsion engine systems.*

CO5: *Select and design space propulsion systems.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	M	H	M						L		M	H	L
CO2	L	L	M	H	M						L		M	H	L
CO3	L	L	L	H	M						L		M	H	L
CO4	L	L	M	H	M						L		M	H	L
CO5	L	L	M	H	M						L		M	H	L
16MPEX09	L	L	M	H	M						L		M	H	L

L-Low, M-Moderate(Medium), H-High

16MPEX10 **INDUSTRIAL ROBOTICS** **CATEGORY:PE**

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MES402 Applied Electronics and Microprocessor
16MPC403 Kinematics of Machines
16MPC505 Hydraulics and Pneumatic Controls

COURSE OBJECTIVES:

* *To familiarize students with the concepts and techniques of robot manipulator, its kinematics, programming and build confidence to choose, evaluate and incorporate robots in engineering systems.*

UNIT – I FUNDAMENTALS OF ROBOT (9)

Robot - definition - robot anatomy - work envelope - types and classification - joint notations – types of joints - robot parts and their functions - specifications - speed of motion - pay load - precision of movement - need for robots in Indian scenario.

UNIT – II ROBOT DRIVE SYSTEMS AND END EFFECTORS (9)

Drives - hydraulic, pneumatic, mechanical, electrical - servo motors - stepper motors - salient features, application - end effectors – types: tools - grippers - mechanical grippers - pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, multiple grippers.

UNIT – III SENSORS AND MACHINE VISION (9)

Requirements of sensors – principles, types and applications of - proximity (inductive, Hall effect, capacitive, ultrasonic and optical) – range (Triangulation, structured light approach) – speed, position (resolvers, optical encoders) – force – torque – touch sensors (binary, analog sensor) - introduction to machine vision - functions - image processing and analysis – training the vision system.

UNIT – IV ROBOT KINEMATICS AND ROBOT PROGRAMMING (9)

Forward kinematics and reverse kinematics of manipulators - two, three degrees of freedom (in 2 dimensional) – homogeneous transformation matrix - simple problems - lead through programming, robot programming languages - VAL programming – motion commands - sensor commands - end effecter commands - simple programs for loading, unloading and palletizing operations.

UNIT – V APPLICATIONS, IMPLEMENTATION AND ROBOT ECONOMICS (9)

Robot cell design – types - Application of robots in processing - assembly - inspection - material handling - loading - unloading - automobile – medical field - implementation of robots in industries - safety considerations for robot operations - economic analysis of robots - pay back method and rate of return method.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *M.P.Groover, "**Industrial Robotics – Technology, Programming and Applications**", McGraw-Hill, 2012.*
2. *M.P.Groover , R.Sivaramakrishnan"**Automation, Production Systems, Computer Integrated Manufacturing**" Pearson Education, New Delhi, **2016.***

REFERENCE BOOKS

1. *Ramachandra Raju, "**Introduction to Industrial Robotics**", Pearson, 1st Edition, **2016**.*
2. *Fu.K.S. Gonzalz.R.C., and Lee C.S.G., "**Robotics Control, Sensing, Vision and Intelligence**", Mc Graw Hill Book Co., 1987.*
3. *Richard D.Klafter, Thomas A.Chmielewski and Micheal Negin, "**Robotic engineering –An Integrated Approach**", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 2005.*
4. *Cameron Hughes, Trarey Hughes, "**Robot Programming**", Pearson, 5th Ed., **2016**.*
5. *Yoram Koren, "**Robotics for Engineers**", McGraw-Hill Book Co., 1992.*

COURSE OUTCOMES:

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

***CO 1:** Appreciate the importance of robot in current scenario to select robots for various applications.*

***CO2:** Control the robot actuation by selecting appropriate drives considering design and environmental requirements.*

***CO3:** Apply production systems with sensors and advanced techniques such as machine vision and manipulator motion analysis*

***CO4:** To analyse the manipulator motion and program it to perform varieties of tasks using modern software tools.*

***CO5**: Select and employ the robots in industries as part of programmable automation tool at reasonable cost to meet challenges of globalisation, adopt robot technology for various applications considering the economic aspects and safety aspects.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M				H			L					H		
CO2	M												H	M	
CO3	L	H			H								H	M	
CO4	L	M			M								L	M	
CO5	L					H	M				L				
16MPEX10	L	L			M	L	L	L			L		M	L	

L-Low, M-Moderate(Medium), H-High

16MPEX11 PLANT LAYOUT AND MATERIAL HANDLING CATEGORY:PE

(Common to Production Engineering)

	L	T	P	C
PRE-REQUISITES: NIL	3	0	0	3

COURSE OBJECTIVES:

- *To understand basic layout and the usage of material handling equipments for industries and gain knowledge on industrial buildings and utilities*

UNIT – I INTRODUCTION (9)

Factors to be considered for plant layout - physical facilities - equipments required for plant operation. Capacity, serviceability and flexibility and analysis in selection of equipments space requirements, man power requirements.

UNIT – II PLANT LAYOUT (9)

Plant layout - need for layout, factors influencing product, process, fixed and combination layout - tools and techniques for developing layout, process chart, flow diagram, string diagram, template and scale models - machine data. Layout planning procedure. Visualization of layout revision and improving existing layout, balancing of fabricating and assembly lines.

UNIT – III MATERIAL HANDLING (9)

Principles, importance and scope of material handling. Planning, operation and costing principles - types of material handling systems, factors influencing their choice.

UNIT – IV UTILITIES (9)

Industrial buildings and utilities - centralized electrical pneumatic water line systems. Types of building, lighting heating, ventilation and air - conditioning utilities. Planning and maintenance of waste handling statutory requirements. Packing and storage of materials - layout for packaging - packaging machinery - wrapping and packing of materials, cushion materials.

UNIT – V ANALYSIS OF MATERIAL HANDLING (9)

Analysis of material handling - factors involved, motion analysis, flow analysis, safety analysis, and equipment cost analysis, analysis of operation and material handling surveys.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. *James, M. Apple**., 'Plant Layout and Material Handling'**, Kreiger Publishing Company, 1991.*
2. *Rudenko. N., **"Materials handling equipment"**, Mir Publishers, 1969.*

REFERENCE BOOKS

1. *James, M. Moore,* ***'Plant Layout and Design'****, Macmillan Company, NY, 1963*
2. *Muther, R.,* ***'Practical Plant Layout'****, McGraw Hill Book Company, NY, 1955*
3. Colin Hardie, **'*Material Handling in Machine Shops'***, Machinery Publication Co. Ltd., London, 1970
4. Alexandrov, M., **'Materials Handling Equipments',** MIR Publishers, 1981.
5. Boltzharol, A., **'Materials Handling Handbook',** The Ronald Press Company, 1958.

COURSE OUTCOMES:

On completion of this course the student will be able to

CO1: *Design plant layout for any type of industries.*

CO 2: *Perform effective selection and utilization of buildings and utilities.*

CO 3: *Select and utilize suitable material handling equipment.*

CO 4: *Plan appropriate HVAC system for industrial buildings.*

CO 5*: Analyze the usage of material handling equipments.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	M	L	M		L	L		L	L		L		L	L	L
CO 2	M	L	M			L		L	L		L		L	M	L
CO 3	M	L	M			L		L	L		L		L	L	L
CO 4	H	L	M			L		L	L		L		L	L	L
CO 5	M	L	M		M	L		L	L		L		L	L	L
16MPEX11	M	L	M		L	L		L	L		L		L	L	L

L-Low, M-Moderate(Medium), H-High

16MPEX12 **MECHANICAL VIBRATIONS** **CATEGORY:PE**

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MES206 Engineering Mechanics.
16MPC503 Dynamics of Machines

COURSE OBJECTIVES:

- *To introduce the fundamentals in Vibration, Vibration analysis of systems. To develop a working knowledge required to understand the physical significance and design, analyze the vibration systems with desired conditions.*

UNIT - I FUNDAMENTAL ASPECTS OF VIBRATIONS (9)

Kinematics of simple vibrating motion - Simple harmonic motions - Vectorial representation of harmonic motion - Degree of freedom - Equations of motions - general solution of free vibration - fourier series and harmonic analysis –Workdone by harmonic force

UNIT - II FREE VIBRATIONS (9)

Undamped free vibration-differential equations – torsional vibrations - eqivalent stiffness of spring combinations - Transverse vibrations of beams – beams with several masses - Bifilar suspension - free damped vibration – types - differential equations of free damped vibration – Critical damping - applications of critical damping

UNIT - III FORCED VIBRATIONS (9)

Sources of excitation - Equations of motion with harmonic force - response of rotating and reciprocating unbalance system - vibration isolation – transmissibility - forced vibrations with coulomb damping ,viscous damping- vibration measuring instruments

UNIT – IV MULTI DEGREES FREEDOM SYSTEM (9)

Vibrations of undamped two degrees of freedom systems – Forced vibrations - damped free vibrations - forced harmonic vibrations - coordinate coupling - Several degrees of freedom system - influence coefficient - generalized coordinates - matrix method - orthogonality principle - eigen values and eigenvectors

UNIT - V CONTINUOUS SYSTEMS (9)

Transverse vibration of strings - Longitudinal vibrations of bars - Lateral vibration of beams - Torsional vibration of circular shafts - Whirling of shafts. Introduction - Method of Laplace transformation and response to an impulsive output - response to step-input, pulse-input, and phase plane method.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *V.P.Singh, **"Mechanical Vibrations",** Dhanapatrai & Sons, 2005*
2. *Thomson.,"**Mechanical Vibration**", Prentice Hall, 1998.*

REFERENCE BOOKS

*1. G.K. Grover, **"Mechanical vibration",**Nemchand Chand and Sons, 2010*

*2. Den Hartog, "**Mechanical Vibration**", Waveland PrInc,2002*

3.Mechanical Vibrations (English) 4Th Edition (Paperback, Singiresu S. Rao),Printice hall,2010

COURSE OUTCOMES:

At the end of the course students will be able to

- ***CO 1:*** *Study the basics of vibration.*
- ***CO 2:*** *Formulate mathematical models of problems in vibrations*
- ***CO 3:*** *Determine a complete solution to mechanical vibration problems using mathematical or numerical techniques.*
- ***CO 4:*** *Determine physical and design interpretations from the results*
- ***CO 5:*** *Apply the knowledge to design the vibration system for the requirement of industry*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	L	L	L	L	L	L	L	L	L	L	M	M	L
CO2	H	H	M	L	M	L	L	L	L	L	L	M	M	H	L
CO3	H	M	M	L	L	L	M	M	L	L	L	M	H	H	L
CO4	H	H	M	L	L	L	L	M	L	L	L	H	M	H	L
CO5	H	H	H	L	L	L	L	M	M	L	L	L	H	H	M
16MPEX12	H	H	M	L	L	L	L	M	L	L	L	M	M	H	L

L-Low, M-Moderate(Medium), H-High

16MPEX13 **NEWER PRODUCTION PROCESSES** **CATEGORY:PE**

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC304 Manufacturing Technology I

16MPC406 Manufacturing Technology II

16MPC601 Computer Aided Design and Manufacturing

COURSE OBJECTIVES:

* *To inculcate specialized knowledge and skill in advanced manufacturing processes with different newer production techniques, their process parameters influences on performance during production of parts.*

UNIT - I MODERN MACHINING PROCESSES (9)

Need of modern machining processes – classification and selection of technology – mechanical processes – abrasive jet machining (AJM), water jet machining (WJM), ultrasonic machining (USM).

UNIT - II CHEMICAL METAL REMOVAL PROCESSES (9)

Principle - Electrochemical machining (ECM), electrochemical grinding (ECG), electrochemical deburring and honing – chemical machining (CHM).

UNIT – III THERMAL METAL REMOVAL PROCESSES (9)

Electric discharge machining (EDM), wire cut electric discharge machining (WEDM). Plasma arc machining (PAM), Electron beam machining (EBM), Laser beam machining (LBM), Ion beam machining (IBM).

UNIT –IV FORMING PROCESSES AND FOUNDRY TECHNIQUES (9)

Explosive forming, Electro – hydraulic forming, electro – magnetic forming, dynapak machine - high pressure moulding, squeeze casting, vacuum castings.

UNIT - V RAPID PROTOTYPING (9)

Introduction – advantages – limitations – principle – rapid prototyping systems – stereo - lithography(SLA), selective laser sintering(SLS), fused deposition modeling(FDM), laminated object manufacturing (LOM), solid ground curing (SGC), three dimensional printing. Application of reverse engineering in rapid prototyping.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *P.C.Pandey,* ***"Modern machining processes",*** *Tata McGraw Hill publishing company Ltd. 2011.*
2. *V.K.Jain,****"Advanced Machining Process",*** *Allied Publishers PVT Ltd 2010*

REFERENCE BOOKS

1. *Bhattacharya,* ***"New Technology",*** *Institution of Engineers, 1997.*
2. *CMTI****, "Electrochemical machining"****, Bangalore, 1978*
3. *Gary.F.Benedict,* ***"Nontraditional machining Processes",*** *Marcell Dekker Inc, 2001*
4. *HMT,* ***"Production Technology",*** *Tata McGraw Hill Publishers, 2002.*
5. *Ronenthal. C* ***"Principles of Metal Castings****", Tata McGraw Hill Publishing co. Ltd, 1996*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1*:* *Identify the need and application of non-contact latest machining processes resulting in Quality and accuracy of parts.*

CO2: *Apply the knowledge for different ways of metal removal with suitable sources of chemical and electro-chemical energy*

CO3: *Discover different thermal energy for metal removal process and optimize appropriate process parameter for different techniques.*

CO4: *Identify different forming process and latest techniques in castings of components to meet the global demand.*

CO5: *Select and apply suitable forming process, different rapid prototyping techniques for suitable engineering application*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	M			M	M				L		H		L
CO2	H	M	M	M	L		L				M		M	M	
CO3	L	L	M	M		L	M				L		L	M	
CO4	L	M	L	L		H	L		L		M		M	L	
CO5	M	L	L			L	L						L	L	
16MPEX13	M	L	M	L	L	L	L		L		L		M	L	L

L-Low, M-Moderate(Medium), H-High

16MPEX14 **LEAN MANUFACTURING** **CATEGORY: PE**

(Common to Production Engineering)

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

* *To craft the students to acquire knowledge in lean manufacturing tools, understand various phases involved and methodology in implementing lean in manufacturing scenario*

UNIT – I ORIGIN AND FOUNDATION OF LEAN PRODUCTION (9)

Craft Production – Mass Production – Ford System – Growing Dysfunction – Origin and History of Lean Production. Necessity of Lean Production – Systems and Systems thinking – Construction of Lean Production: Lean image and Lean Activities – Muda and its types – Mura – Muri.

UNIT – II STABILITY (9)

Standards in Lean System – Visual Management – 5S – Total Productive Maintenance: Key measures; Six Big Losses; Hidden Losses; Machine Loss Pyramid; Small group activity. Standardized work: Comparison of Methods Engineering and Lean thinking – Elements to be managed - Necessity and prerequisites of Standardized work – Elements of Standardized work - Charts: Production capacity chart; Standardized combination table; Standardized work analysis chart – Man power reduction – Comparison of overall efficiency with individual efficiency – Kaizen – Common Layouts

UNIT – III JUST IN TIME (JIT) (9)

Definition - Principles of JIT: Continuous Flow; Pull – JIT system – Kanban – Six Kanban rules - Expanded role of conveyance – Production leveling – Three types of Pull Systems – Value Stream Mapping: Symbols; Current state VSM and Future state VSM.

UNIT – IV JIDOKA (9)

Development and necessity – Poke Yoke: Common errors – Inspection system and Zone control – Using Poke Yokes – Jidoka implementation.

UNIT – V LEAN INVOLVEMENT AND CULTURE (9)

Necessity of involvement – Waste of Humanity – Activities supporting involvement – Kaizen Circle Activity – Practical Kaizen Training – Key factors in Practical Kaizen Training – Lean Culture – Standardization – Standards and abnormality control – 'Five Why' analysis.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOK

1. *Dennis P,* ***"Lean Production Simplified: A Plain Language Guide to the World's Most Powerful Production System"****, Productivity Press, New York, 2007.*

REFERENCE BOOKS

1. *Devadasan S R, Mohan Sivakumar V, Murugesh R and Shalij P R,* ***"Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities"****, Prentice Hall of India Learning Limited, New Delhi, 2012.*
2. *Gopalakrishnan N,* ***"Simplified Lean Manufacture: Elements, Rules, Tools and Implementation"****, Prentice Hall of India Learning Private Limited, India, 2010.*
3. *Bill Carreira,* ***"Lean Manufacturing that Works: Powerful Tools for Dramatically Reducing Wastes and Maximizing Profits"****, Prentice Hall of India Learning Private Limited, India, 2007.*
4. *Don Tapping, Tom Luyster and Tom Shuker,* ***"Value Stream Management: Eight Steps to Planning, Mapping and Sustaining Lean Improvements"****, Productivity Press, New York, USA, 2002.*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1*: Describe about the origin and foundation of lean production.*

CO2*: Describe about stability and standards in lean system.*

CO3*: Describe about Just In Time (JIT) and its application in lean.*

CO4*: Describe about Jidoka and Poke Yoke.*

CO5: *Describe about lean involvement and culture.*

COURSE ARTICULATION MATRIX:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	L		M		L	H	M				L	L		L	
CO 2	M	L		M	L	M	L		L			M	M	M	
CO 3			H	L					L	M				L	M
CO 4	H	L		M		M		L				M	L	H	
CO5		M	H		L		L		L						
16MPEX14	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L

L-Low, M-Moderate(Medium), H-High

16MPEX15 **WELDING TECHNOLOGY** **CATEGORY:PE**

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC304 Manufacturing Technology I
16MPC305 Engineering Metallurgy

COURSE OBJECTIVES:

- *To create the awareness of welding process and to know importance of it*
- *Inspection methods of welded products and also helps to know the material considerations of this operation*

UNIT - I FUNDAMENTALS OF WELDING PROCESSES (9)

Classification and characteristics - welding processes and methods-Arc welding equipment's - Electrodes – Coatings – Principles of Resistance welding – spot welding-seam welding – Percussion welding - Gas metal arc welding – Flux cored – Submerged arc welding – TIG welding - ultrasonic welding - explosive welding- diffusion welding - friction welding.

UNIT - II SPECIAL WELDING PROCESSES (9)

Plasma Jet Surfacing - vacuum shielded - electron beam welding - laser beam welding, friction stir welding, hybrid welding - Underwater welding - brazing and soldering - wetting and spreading - joint design of soldering and brazing, brazing and soldering fluxes.

UNIT - III INSPECTION AND TESTING OF WELDMENTS (9)

Testing of welds - quality in weldment - computer applications in welding - expert systems in welding - weldability of stainless steel, cast iron, aluminum alloys and titanium alloys, low alloy steels and ultra-high strength steels - weldability assessment and weldability tests

UNIT - IV WELDING OF DISSIMILAR AND NON-METALLIC MATERIALS (9)

Welding of dissimilar metals - welding of ceramics, composites, micro welding of thin components - defects in weldments, mechanism- reasons and remedies of cold cracking- hot cracking- reheated cracking and lamellar tearing - NDT evaluation of weldments

UNIT - V WELDING METALLURGY (9)

Weld thermal cycles – Heat Affected Zone (HAZ) – Weldability of steels – Cast Iron –Stainless steel, aluminum – Copper and Titanium alloys – Hydrogen embrittlement – Pro and post weld heat Treatments – weld defects.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *Parmer R.S., **"Welding Engineering and Technology"**, Khanna Publishers, New Delhi, 1997.*
2. *Howard B. Cary, Scott C. Helaer., **"Modern Welding Technology"**, Pearson Education. Ltd, 2011.*

REFERENCE BOOKS

1. *Nadkarni S.V.,* ***"Modern Arc Welding Technology",*** *South Asia Books, 1988.*
2. *Little R.L.,* ***"Welding and welding Technology"****, Tata McRaw Hill Publishing Co., Ltd., New Delhi, 1989.*
3. *A.Elango, K.Kalaiselvan,* ***"Laser Welding Technology****", Anuradha Publications, Chennai,2016.*
4. *O.P.Khanna****, "Welding Technology****", DhanpatRai and sons, 2008.*
5. *Baldev Raj, V. Shankar, A.K.Bhaduri,* ***"Welding Technology for Engineers"****, Alpha Science International, 2006.*

COURSE OUTCOMES:

Upon completion of the course, student will be able to

- ***CO 1:*** *Provide the principle of the welding process for joints production to the machine products*
- ***CO 2:*** *Operate the latest and special welding process for uncommon new and specialized components*
- ***CO 3:*** *Investigate the quality of welded portion of machine component*
- ***CO 4:*** *Join the different dissimilar materials as per requirement and inspecting its quality*
- ***CO 5:*** *Understood the welded material physical and chemical property changes due to the welding operation*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	M		L										L		
CO 2				L							M			L	L
CO 3	M	M									L		M	L	
CO 4	L	L					M						L		
CO 5	L					L			L		M		M	L	
16MPEX15	L	L	L	L		L	L		L		L		L	L	L

L-Low, M-Moderate(Medium), H-High

16MPEX16 **THEORY OF METAL CUTTING** **CATEGORY:PE**

(Use of approved data book is permitted)

(Common to Production Engineering)

L	T	P	C
3	0	0	3

PRE-REQUISITES

16MES206 Engineering Mechanics
16MBS1Z2 Engineering Mathematics
16MPC502Thermal Engineering

COURSE OBJECTIVES:

* *To familiarize students about the basic mechanics, thermal, wear and chatter mechanisms in metal cutting processes.*

UNIT - I ORTHOGONAL CUTTING (9)

Basic mechanism of chip formation –Techniques for study of chip formation, types of chips - Chip breaker - Orthogonal Vs Oblique cutting – Shear plane angle - Cutting force and velocity relationship in orthogonal cutting - Modern theories in Mechanics of cutting - Review of Merchant and Lee Shaffer Theories.

UNIT - II OBLIQUE CUTTING (9)

Direction of Chip flow - Normal Velocity and Effective Rake angles - Relationship between rake angles - Cutting ratios in oblique cutting - Shear angle and Velocity relationship - Stabler's rule.

UNIT - III THERMAL ASPECTS OF MACHINING (9)

Heat distributions in machining - Experimental determination and Analytical calculation of cutting tool temperature -Heat in primary shear Zone, Heat in Tool / Work Interface, Heat in Areas of Sliding - effects of various parameters on temperature -Cutting fluids - Effects of cutting fluid - Functions - Requirements - Types and Selection of Cutting Fluids.

UNIT - IV CUTTING TOOL MATERIALS, TOOL LIFE AND TOOL WEAR (9)

Essential requirements of tool materials - Structure and properties of High speed steel and Cemented carbides - development in tool materials - ISO specification for inserts and tool holders - tool life - conventional and accelerated tool life tests - concept of machinability index - economics of machining - Reasons for failure of cutting tools and forms of wear - mechanisms of wear

UNIT - V DESIGN OF CUTTING TOOLS (9)

Nomenclature of Single point and Multi point cutting tools - Design of Turning tool, Drills, Milling cutters and tool holders.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *Boothroid D.G. & Knight W.A.,* ***"Fundamentals of machining and machine tools"****, Marcel Dekker, Newyork, 1989.*

REFERENCE BOOKS

1. *Shaw.M.C. , "****Metal cutting principles"****, Oxford Clare don press, 1984.*
2. *Bhattacharya.A.,* ***"Metal Cutting Theory and practice"****, Central Book Publishers, India, 1984.*

COURSE OUTCOMES

On completion of this course the student will be able to

CO1: *Elaborate the mechanisms of chip formation in different types of metal cutting processes.*

CO2*: Predict the magnitude of cutting forces for a tool at the given operating conditions.*

CO3: *Realize the thermal effect of cutting process in and around the cutting region.*

CO4: *Predict the effect of cutting parameters on life of different cutting tools.*

CO5: *Design a cutting tool for metal cutting process.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	H	L	M	L		M	L		L		L		L	M	L
CO 2	H	H	H	H		M	L		L		L		M	M	L
CO 3	H	H	H	H		M	L		L		L		M	M	L
CO 4	H	H	H	H		M	L		L		L		M	M	L
CO 5	H	H	H	L		H	L		L		L		H	M	L
16MPEX16	H	H	H	M		M	L		L		L		M	M	L

L-Low, M-Moderate(Medium), H-High

16MPEX17 **ROBUST DESIGN** **CATEGORY:PE**

(Common to Production Engineering)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MBS1Z2 Engineering Mathematics I
16MBS2Z2 Engineering Mathematics II
16MB 3Z1 Engineering Mathematics III

COURSE OBJECTIVES:

To impart knowledge to design experiments to a problem situation using traditional experimental designs as well as Taguchi Methods.

UNIT - I EXPERIMENTAL DESIGN FUNDAMENTALS (9)

Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps in experimentation, sample size, normal probability plot and linear regression models.

UNIT - II SINGLE FACTOR EXPERIMENTS (9)

Completely randomized design, Randomized block design, Latin square design - Statistical analysis, estimation of model parameters, model adequacy checking, pair wise comparison tests.

UNIT - III MULTIFACTOR EXPERIMENTS (9)

Two and three factor full factorial experiments, Randomized block factorial design, Experiments with random factors, rules for expected mean squares, approximate F - tests. 2K factorial Experiments

UNIT - IV SPECIAL EXPERIMENTAL DESIGNS (9)

Blocking and confounding in 2k designs. Two level Fractional factorial design, nested designs, Split plot design, Response Surface Methods

UNIT - V TAGUCHI METHODS (9)

Steps in experimentation, design using Orthogonal Arrays, data analysis, Robust design- control and noise factors, S/N ratios, parameter design, Multi-level experiments, Multi - response optimization.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. A. Mitra, "**Fundamentals of Quality Control and Improvement"**, Pearson Publication, 1998
2. Phillip J.Rose, "**Taguchi techniques for quality engineering"**, McGraw Hill, 1996

REFERENCE BOOKS

1. *Montgomery, D.C., "**Design and Analysis of experiments"**, John Wiley and Sons, Eighth edition, 2012.*
2. *Krishnaiah, K. and Shahabudeen, P. "**Applied Design of Experiments and Taguchi Methods"**, PHI learning private Ltd., 2012.*
3. *Nicolo Belavendram, "**Quality by Design; Taguchi techniques for industrial experimentation"**, Prentice Hall, 1995.*
4. *J. Krottmaier, "**Optimizing Engineering Design"**, McGraw Hill Ltd, 1993*
5. *Madhav Shridhar Phadke, "**Quality Engineering Using Robust Design",** Prentice Hall, 1985*

COURSE OUTCOMES

On completion of this course, students will be able to

***CO 1:** Select appropriate tools for robust design.*

***CO 2**: Identify and implement single factor experiments*

***CO 3**: Identify and implement multi factor experiments*

***CO 4:** Apply the concepts of .special experiment designs*

***CO 5:** Apply the concepts of Taguchi experiment design for practical problems.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	M	H		L				L		L		L	L	L
CO2	L	M	H		L				L		L		L	L	L
CO3	L	M	H		L				L		L		L	L	L
CO4	L	M	H		L				L		L		L	L	L
CO5	L	M	H		L				L		L		L	L	L
16MPEX17	L	M	H		L				L		L		L	L	L

L-Low, M-Moderate(Medium), H-High

16MPEX18 **ADDTIVE MANUFACTURING** **CATEGORY:PE**

(Common to Production Engineering)

L	T	P	C
3	0	0	3

PREREQUISITES:

16MPC601 Computer Aided Design and Manufacturing.
16MPC304 Manufacturing technology I
16MPC406 Manufacturing technology II

COURSE OBJECTIVES:

* *To educate students with fundamental and advanced knowledge in the field of Additive Manufacturing technology and the associated Aerospace, Architecture, Art, Medical and Industrial applications.*

UNIT - I INTRODUCTION (9)

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM - Classification of AM processes – Benefits – Applications- Software for AM- Case studies.

UNIT - II REVERSE ENGINEERING AND CAD MODELING (9)

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wireframe, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation.

UNIT – III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS (9)

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and application. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications.

UNIT - IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS (9)

Selective Laser Sintering (SLS): Principle, process, indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications – case Studies, Selective Laser Melting and Electron Beam Melting.

UNIT - V OTHER ADDITIVE MANUFACTURING SYSTEMS (9)

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, Demerits, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Bio Additive Manufacturing (BAM).

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *Chua Chee Kai and Leong Kah Fai,* ***"Rapid Prototyping: Principles and Applications in Manufacturing"****, John Wiley and Sons, 1997*
2. *Paul F. Jacobs, ,* ***"Stereo-lithography and other RP & M Technologies": from Rapid Prototyping to Rapid Tooling"****, SME/ASME,1996.*

REFERENCE BOOKS

1. *Gibson, I., Rosen, D.W. and Stucker, B.,* ***"Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing"****, Springer, 2010.*
2. *Chua, C.K., Leong K.F. and Lim C.S., "****Rapid prototyping: Principles and applications"****, second edition, World Scientific Publishers, 2010.*
3. *Gebhardt, A.,* ***"Rapid prototyping"****, Hanser Gardener Publications, 2003.*
4. *Liou, L.W. and Liou, F.W.,* ***"Rapid Prototyping and Engineering applications: A tool box for prototype development"****, CRC Press, 2011.*
5. *Hilton, P.D. and Jacobs, P.F.,* ***"Rapid Tooling: Technologies and Industrial Applications"****, CRC press, 2005.*

COURSE OUTCOMES:

On completion of this course, students will be able to

- ***CO 1:*** *Appreciate the importance of computers and modern tools in manufacturing to Reduce cost and matching the societal needs.*
- ***CO 2:*** *Create and analyze 2D and 3D models using CAD modeling software and integrating with manufacturing systems.*
- ***CO 3:*** *Understand the variety of Additive Manufacturing (AM) technologies apply to their Potential to support design and manufacturing, case studies relevant to mass customized manufacturing.*
- ***CO 4****: Apply knowledge on latest techniques of manufacturing in their field of career*
- ***CO 5****: To monitor and control shop floor with the aid of computers*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	L	H			M						L	L	
CO2	M		M	H										M	L
CO3		M	L	H									M	L	
CO4			M		H	M	L						M	H	L
CO5		M				L					M		L	H	
16MPEX18	L	L	L	L	L	L	L				L		L	M	L

L-Low, M-Moderate(Medium), H-High

16MPEX19 ENTREPRENEURSHIP DEVELOPMENT CATEGORY:PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MHS701 Engineering Economics and Management

COURSE OBJECTIVE:

* *To identify and apply the concepts of entrepreneurship and to behave responsibly and ethically in their role of entrepreneurs in selection of the opportunity and management of resources and utilization of the support from Government and monetary institutions.*

UNIT - I INTRODUCTION TO ENTREPRENEURSHIP (9)

Evolution of the concept of entrepreneurship, Characteristics of entrepreneurs, Functions of entrepreneurs, Types of Entrepreneurs, Differences with managers, Growth of entrepreneurship in India, Role of entrepreneurship in economic development, Factors affecting growth of entrepreneurship, Entrepreneurial competencies.

UNIT – II START-UP OF ENTREPRENEURIAL VENTURES (9)

Opportunity identification and selection, Establishment of incubation centres, Formulation of business plans, Project appraisal - Methods, Financing of ventures - Sources of finance-Internal and external sources, Forms of ownership, Legal issues of setting of ventures - Patents, Copyrights, trademarks.

UNIT – III SUPPORT SYSTEM FOR ENTREPRENEURS (9)

Institutional support for entrepreneurs - Commercial banks, Other financial institutions, Taxation benefits - Tax holiday, Investment allowance, Rehabilitation allowance, Amortization of certain preliminary expenses, Important provisions of the Industrial Policy Resolution

UNIT – IV MANAGEMENT OF THE VENTURES (9)

People Management - Leadership, Motivation, Communication, challenges caused by workforce diversity, Working Capital Management- Assessment of working capital, Factors determining working capital requirement, Working capital cycle, Inventory Management- Motives for holding inventories, Methods of inventory management.

UNIT – V STRATEGIES FOR GROWTH, SUCCESSION PLANNING, ENDING THE VENTURE (9)

Growth strategies - Penetration of market, Product development, Market development, Diversification, External sources for growth - Joint ventures, Acquisitions, Mergers and Franchising, Succession planning- Transfer to family members, Selling the business, bankruptcy laws in India.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. *Khanka,S.S., **"Entrepreneurial Development"** S.Chand & Company Private Limited, New Delhi, 2015*
2. *Hisrich, Manimala, Peters, Shepherd, **"Entrepreneurship"** McGraw Hill Education Private Limited, New Delhi, 2014*

REFERENCE BOOKS

1. *Bruee R Barringer and Duane Ireland, **"Entrepreneurship – Successfully Launching New Ventures"**, Pearson – Prentice Hall, 2006.*
2. *Marc J Dollinger, **"Entrepreneurship – Strategies and Resources"**, Pearson Education, 2003.*
3. *Mary Coulter, **"Entrepreneurship in Action"**, Prentice Hall of India, 2006.*
4. *Robert D Hisrich, Michael P Peters and Dean Shepherd, **"Entrepreneurship"**, Tata McGraw Hill, 2007.*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: *Provide an accurate self-analysis for an entrepreneurial career.*

CO2: *Find an attractive market and decide on the most suitable source of finance for the same.*

CO3: *Design and develop a entrepreneurial venture that would enjoy the maximum support from financial institutions and the Government.*

CO4: *Successfully meet the challenges of motivating and communicating with a diverse workforce.*

CO5: *Find alternative strategies to save a venture that is unable to sustain on its own.*

COURSE ARTICULATION MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1												H	H		M
CO2					M						M		L		
CO3								L	L			L			L
CO4								M	M	H					H
CO5				L				M					H		L
16MPEX19				L	L			L	L	L	L	L	L		L

L-Low, M-Moderate(Medium), H-High

16AOEX01 **NANOSCIENCE AND TECHNOLOGY** **CATEGORY: OE**

(Common to All Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To Understand and analyze the concepts of Quantum confinement, Dimensional structures and Properties of nano systems*
- *To be familiar with various methods of synthesis of nano materials*
- *To analyze and understand the mechanical and electrical properties of nonmaterial and its applications*
- *To realize the importance of Nonporous materials and its applications*
- *To make the students to understand the fundamental aspects of properties leading to technology*

UNIT - I NANO SYSTEMS (9)

Size effect and properties of nanoparticles - particle size - particle shape - particle density - melting point, surface tension, wettability - specific surface area and pore size – Properties of Individual nanoparticles. Quantum confinement in 3D, 2D, 1D and zero dimensional structures -Size effect and properties of nanostructures- Top down and Bottom up approach.

UNIT - II SYNTHESIS OF NANOMATERIALS (9)

Sol-Gel Process - Self assembly - Electrodeposition - Spray Pyrolysis - Flame Pyrolysis – Metal Nanocrystals by Reduction - Solvothermal Synthesis - Chemical Vapor Deposition (CVD) – Metal Orgonic Chemical Vapor Deposition (MOCVD).Ball Milling - Inert Gas Condensation Technique (IGCT) – Thermal evaporation – Pulsed Laser Deposition (PLD) – DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE) – Melt Spinning process.

UNIT - III MECHANICAL AND ELECTRICAL PROPERTIES (9)

Nanoscale Mechanics - Introduction – Mechanical properties – Density Considered as an Example Property – The Elasticity of Nanomaterials – Elasticity of Bulk Nanomaterials – Plastic Deformation of Nanomaterials - The Physical Basis of Yield Strength – Crystals and Crystal Plasticity – From Crystal Plasticity to Polycrystal Plasticity.

Introduction - Energy Storage Basics - General Information: Electrical Energy Storage Devices and Impact of Nanomaterials – Batteries – Capacitors - Electrochemical Properties of Nanoscale Materials - Aerogels and Structure-Directed Mesoporous and Macroporous Solids - Nanoparticles - Nanotubes, Nanowires, and Nanorolls

UNIT - IV NANOPOROUS MATERIALS (9)

Nanoporous Materials – Silicon - Zeolites, mesoporous materials – nano membranes and carbon nanotubes - AgX photography, smart sunglasses and transparent conducting oxides- Hydrophobic & Hydrophilic materials – molecular sieves – nanosponges.

UNIT - V NANOTECHNOLOGY APPLICATIONS (9)

Applications of nanoparticles, quantum dots, Nanotubes and nanowires for nanodevice fabrication – Single electron transistors, coulomb blockade effects in ultra-small metallic tunnel junctions - nanoparticles based solar cells and quantum dots based white LEDs – CNT based transistors – principle of Dip Pen Lithography.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

REFERENCE BOOKS:

1. G. Timp. Editor, "**Nanotechnology**" AIP press, Springer-Verlag, New York, 1999
2. Hari Singh Nalwa, Editor, **"Nanostructured materials and Nanotechnology"**, Concise Edition, Academic Press, USA (2002).
3. Guozhong Gao, "**Nanostructures & Nanomaterials: Synthesis, Properties & Applications"**, Imperial College Press (2004).
4. K. T. Ramesh, "**Nanomaterials : Mechanics and Mechanisms"**, Springer 2009.
5. Kenneth J. Klabunde, "**Nanoscale materials in chemistry"**, John Wiley & Sons, 2001.
6. Hari Singh Nalwa, Editor, "**Hand book of Nanostructured Materials and Technology"**, Vol.1-5, Academic Press, USA (2000).
7. "**Hand book of Nanoscience, Engineering and Technology"** (The Electrical Engineering handbook series), Kluwer Publishers, 2002
8. N John Dinardo, Weinheim,"**Nanoscale characterization of surfaces & interfaces"**, Cambridge: Wiley-VCH, 2nd ed., 2000
9. G. Cao, "**Nanostructures & Nanomaterials: Synthesis, Properties &Applications"**, Imperial College Press, 2004.
10. J.George, "**Preparation of Thin Films"**, Marcel Dekker, Inc., New York. 2005.

COURSE OUTCOME

CO1 : *Analyze the particle size, particle shape, particle density, Size effect and properties of nanostructures. [Familiarity]*

CO2 : *Acquire knowledge in various methods of synthesis of Nano materials. [Application]*

CO3 : *Analyze the Elasticity of Nanomaterials , Electrical Energy Storage Devices and Aerogels. [Assessment]*

CO4: *Acquire knowledge in Zeolites, mesoporous materials, nano membranes and carbon nanotubes. [Familiarity]*

CO5: *Apply various nano materials to the LED, Transistor Applications. [Usage and Assessment]*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		H		M		L									
CO2	M			L	H										
CO3		H			L		M						H		
CO4	H			M		L								H	
CO5	L		H				M					M			H
16AOEX01	L	L	L	L	L	L	L					L	L	L	L

L-Low, M-Moderate(Medium), H-High

16AOEX02 **MATERIAL CHARACTERIZATIONS** **CATEGORY: OE**

(Common to All Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To Understand and analyze the concepts of Thermo gravimetric analysis, Differential thermal analysis.*
- *To be familiar with various methods of microscope*
- *To analyze and understand the working principle of SEM, FESEM, EDAX, and HRTEM*
- *To realize the importance of Electrical methods and its limitations*
- *To understand the fundamental aspects and properties of spectroscopy techniques*

UNIT – I THERMAL ANALYSIS (9)

Introduction – thermo gravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves - differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermo mechanical parameters .

UNIT – II MICROSCOPIC METHODS (9)

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy - phase contrast microscopy - fluorescence microscopy - confocal microscopy - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.

UNIT – III ELECTRON MICROSCOPY AND OPTICAL CHARACTERISATION (9)

SEM- FESEM- EDAX - HRTEM: working principle and Instrumentation – sample preparation – Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.

UNIT – IV ELECTRICAL METHODS (9)

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V, I-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations.

UNIT – V SPECTROSCOPY (9)

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, ESCA and SIMS - proton induced X-ray Emission spectroscopy (PIXE) – application – mass spectroscopy.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

REFERENCE BOOKS

1. *Stradling, R.A; Klipstain, P.C;* ***"Growth and Characterization of semiconductors"****, Adam Hilger, Bristol,1990.*
2. *Belk, J.A;* ***"Electron microscopy and microanalysis of crystalline materials"****, Applied Science Publishers, London, 1979.*
3. *Lawrence E.Murr,* ***"Electron and Ion microscopy and Microanalysis principles and Applications"****, Marcel Dekker Inc., New York, 1991*
4. *D.Kealey & P.J.Haines,* ***"Analytical Chemistry"****, Viva Books Private Limited, New Delhi, 2002.*
5. *G. Gao,* ***"Nanostructures and Nanomaterials"****, Imperial College Press, London, 2006*
6. *Y. Gogotsi,* ***"Nanomaterials Handbook"****, CRC Taylor and Francis, New York, 2006*
7. *Banwell,* ***"Fundamentals of Molecular Spectroscopy"****, Tata McGraw-Hill, 1994.*

COURSE OUTCOME

CO1*: Analyze the properties of TGA,DTA and DSC. [Assessment]*

CO2: *Acquire knowledge in various types of microscopes. [Familiarity]*

CO3 : *Analyze the working principle and Instrumentation of SEM, FESEM, EDAX, and HRTEM [Familiarity]*

CO4: *Acquire knowledge in I-V and C-V characteristics. [Application]*

CO5: *Analyze the Principles and instrumentation of Spectroscopy methods. [Familiarity*]

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		H			M	M	L						H		
CO2	H	M	M				L					L			
CO3		H	M	M	L									H	
CO4	M	H		L	M										H
CO5		M	H		L	M						L			
16AOEX02	L	H	L	L	L	L	L					L	L	L	L

L-Low, M-Moderate(Medium), H-High

16AOEX03 **ELECTROCHEMICAL TECHNOLOGY** **CATEGORY:OE**

(Common to All Branches)

	L	T	P	C
PRE-REQUISITES : *Nil*	3	0	0	3

COURSE OBJECTIVES:

* *This course aims at making Mechanical Engineers know about Electrochemical principles applied in manufacturing of Chemical products, fabrication of metals, metallurgy and corrosion studies*

UNIT – I **(09)**

Fundamental concepts, electron transfer, mass transfer, adsorption, electro-catalysis, phase formation in electrode reaction, assessment of cell voltage, costing of electrolytic process, performance and figure of merit. Typical cell designs. Laboratory data and scale-up.

UNIT – II **(09)**

Chlor-alkali industry-concept of brine electrolysis, chlorine cell technology, the production of NaOH. Water electrolysis, sodium chlorate, hydrogen peroxide, ozone, cuprous oxide and synthesis of metal salt via anodic dissolution, Organic electro synthesis - dimerization of acrylonitrile, indirect electrosynthesis

UNIT – III **(09)**

The extraction, refining and production of metal – electro-winning, cementation, electro-refining, Electro-deposition of metal powders. Corrosion and its control - thermodynamics and kinetics of corrosion reactions, corrosion problems in practice, corrosion prevention and control, corrosion problems in electrolytic processing, corrosion measurement and monitoring

UNIT – IV **(09)**

Metal finishing-electroplating, electroless plating, conversion coatings, electroforming, electrochemical etching. Batteries and fuel cells - battery characteristics, battery specifications, evaluation of battery performance, battery components. Fuel cells.

UNIT – V **(09)**

Water purification, effluent treatment and recycling of industrial process stream- metal ion removal and recovery, treatment of liquors containing dissolved chromium, electrolytic method of phase separation, flue gas desulphurization, electrodialysis. Electrochemical sensor and monitoring techniques, polarographic to anodic stripping voltammetry, ion selective electrode, electrochemical biosensors.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. Derek Pletcher and Frank C Walsh, ***"Industrial Electrochemistry"****, 2nd edition, Chapman & Hall, UK, 1990*

2.A.T.Kuhn, ***"Industrial Electrochemistry"****, Elsevier Publishers, 1972*

REFERENCE BOOKS

1. C.L. Mantell, ***"Chemical Engineering Series – Industrial Electrochemistry"****, McGraw Hill Co., Inc. London, 1958.*

2.Ullmann's ***"Encyclopedia of Industrial Chemistry"****, John Wiley & Sons, Vol.6, pp: 399 - 481, 2003.*

*3.Krik–"****Othmer Encyclopedia of Chemical Technology"****, 4th edition, Vol: I., Pp938 –1025 (1991).*

*4.N.M.Proutand J.S.Moorhouse****, "Modern Chlo-Alkali Technology"****, Vol. IV, Elsevier Applied Science, London, 1990.*

COURSE OUTCOMES

Students after the completion of this course:

CO 1: *Students will be able to understand the electrodic processes and design cell requirements*

CO 2*: Students can apply the electrolysis principle in manufacture of materials required for regular use.*

CO 3*: Students will be able to apply their technical skill in metallurgy.*

CO 4: *Students will be able to acquire knowledge in all metal finishing techniques.*

CO 5*: Students will gain knowledge in solving the problems of corrosion of equipment and battery systems.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	H	M	M	H	L							H		
CO2	L	M	H	L	H	L								M	
CO3	H	L	H	M	M	H								M	
CO4	M	L	L	L	M	H							M	L	
CO5	L	M	H	L	H	M								M	L
16AOEX03	M	M	M	L	H	M							L	L	L

L-Low, M-Moderate(Medium), H-High

16AOEX04 **POLYMER TECHNOLOGY** **CATEGORY:OE**

(Common to All Branches)

PRE-REQUISITES : *Nil*

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

* *This course is aimed to make Mechanical Engineers apply their skills in identifying the types of polymers and their properties applicable to plastics and rubber processing*

UNIT – I CHEMISTRY OF HIGH POLYMERS (09)

Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; metallocene polymers and other newer techniques of polymerization, copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension and emulsion.

UNIT – II SYNTHESIS AND PROPERTIES (09)

Commodity and general purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, ABS, Fluoropolymers - Thermosetting polymers: PF, MF, UF, Epoxy, Unsaturated polyester. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE.

UNIT – III POLYMER TECHNOLOGY (09)

Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, cross-linking and vulcanization,. Compression molding, transfer molding, injection molding, blow molding, reaction, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

UNIT – IV POLYMER BLENDS AND COMPOSITES (09)

Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, FRP, particulate, long and short fibre reinforced composites.

UNIT – V POLYMER TESTING (09)

Mechanical - static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity - thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

REFERENCE BOOKS

*1. F.W. Billmeyer, Jr., **"Textbook of polymer science"**, Wiley - Interscience, N.Y.(1971)*

*2. G.Odian , **"Principles of polymerization"**, , Wiley – Interscience (1981)*

*3. Gowarikar V.R. and others , **"Polymer science"**, Wiley Eastern (1986).*

*4. Fenner R.T., **"Principles of polymer processing"**, Chemical publishing N.Y. (1979)*

COURSE OUTCOMES

Students after the completion of this course:

- ***CO1:*** *Will be able to identify different types of polymers by structure and behaviour, properties and their method of polymerisation.*
- ***CO2****: Will be able to apply various processes of fabrication of plastics and rubber.*
- ***CO3:*** *Will be able to distinguish polymer blends and composites and understand their specific applications.*
- ***CO4****: Will be able to test the polymer specimens for mechanical properties applicable for various end uses.*
- ***CO5****: Will be able to test the polymer specimens for electrical properties applicable for various end uses.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	L	L	M	H							M		
CO2	L	L	H	M	H	L							H	L	
CO3	M	M	L	L	M	L								M	
CO4	L	L	M	M	M	H								M	L
CO5		H	L	L	H	M								H	
16AOEX04	L	M	M	L	M	M							L	M	L

L-Low, M-Moderate(Medium), H-High

16COEX05 DISASTER MANAGEMENT AND MITIGATION CATEGORY:OE

(Common to All Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To give knowledge about basics of Disaster Management.*
- *To impart knowledge about Hazards and Vulnerability.*
- *To give knowledge about mitigation and preparedness.*
- *To teach about Response and Recovery.*
- *To impart knowledge about the participants involved in the disaster management activity.*

UNIT - I INTRODUCTION (08)

Disaster throughout history, History of disaster management, Capacity by demand, UN International strategy for disaster reduction, the Hyogo framework for action, Post 2015 framework, Disaster trends.

UNIT – II HAZARDS AND RISK VULNERABILITY (10)

Hazard Identification and Hazard Profiling, hazard analysis, Types of hazards - Natural and technological Components of Risk - likelihood and Consequence, Trends and Computation of likelihood and Consequence. Risk Evaluation – purpose, Risk Acceptibility, Alternatives, Personnel. Political / social, Economic. Vulnerability - Physical Profile, Social Profile, Environmental Profile, Economic Profile. Factors Influencing Vulnerability, risk Perception.

UNIT - III MITIGATION AND PREPAREDNESS (08)

Mitigation - types of mitigation ,Obstacles in mitigation, Assessment and selection of Mitigation options, Emergency response capacity as , Incorporating Mitigation into development and relief projects

Prepareness - Government Preparedness, Public Preparedness, Media as a public educator. Obstacles to public education and preparedness.

UNIT - IV RESPONSE AND RECOVERY (09)

Response the Emergency - Pre disaster, post disaster, Provision of water, food and shelter, volunteer management , command , control and coordination

Recovery - short term and long term recovery. components of recovery - planning, coordination, information, money and supplies, allocation of relief funds, personnel. Types of recovery- Government, Infrastructure, Debris removal disposal and processing, environment, housing, economic and livelihood, individual, family and social recovery - special considerations in recovery.

UNIT – V PARTICIPANTS (10)

Governmental Disaster management agencies - Fire, law, emergency management, Emergency medical service, Millitary and other resources. Structures - local, regional, national. Bilateral assistance and its types. Types of national agencies involved in international disaster management. Political implications of bilateral assistance.

Non Governmental Organizations – operations, NGO/ Millitary coordination, standard of conduct. The role of Private sector and academia.
Multilateral organizations - UN agencies and progammes, Regional & International organizations. International Financial Institutions- the world bank, IMF, ADB, IADB. Special considerations.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOK

1.Damon P. Coppola, ***"Introduction to International Disaster management"****, Elsevier publication, 2015*

REFERENCE BOOKS

1. Brassard, Caroline, Giles, David W., Howitt, Arnold M., ***"Natural Disaster Management in the Asia-Pacific"****, Policy and Governance.*

2. ***"Disaster Management"****, Global Challenges and Local Solutions, Universities Press, 2009.*

3. Jack Pinkowski, ***"Disaster Management Handbook"****, CRC Press,January 22, 2008.*

4. ***Disaster Management Guidelines****, GOI-UNDP Disaster Risk Reduction Programme (2009-2012).*

COURSE OUTCOMES

CO1: *Able to get knowledge about basics of Disaster management.*

CO2: *Able to impact knowledge about Hazards and vulnerability*

CO3: *Able to know about Mitigation and preparedness.*

CO4: *Able to attain knowledge about response and recovery.*

CO5: *Able to learn about the participants involved in the disaster management activity.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1		L			L	L		L								L
CO2	L	H		M	L	M						L	L			L
CO3	L	L			H	M						L	L			L
CO4	L	M		L	L	M	M									L
CO5		M		L	L	M										L
16COEX05	L	M		L	L	M	L					L	L			L

L-Low, M-Moderate(Medium), H-High

16COEX06 **ENVIRONMENTAL MANAGEMENT** **CATEGORY:OE**

(Common to All Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MHS2Z4 - Environmental Science And Engineering

COURSE OBJECTIVES:

- *To understand the importance of nature and study about the water, air and soil pollution control as well as solid waste management.*

UNIT – I NATURE AND SCOPE OF ENVIRONMENTAL PROBLEMS (09)

Environment and sustainable development – Natural and human environmental disturbances – Global warming –acid rain – ozone depletion – effects and control - climate change conventions – Kyoto protocol – India's efforts for Environmental protection – Public policy and role of NGO's.

UNIT – II WATER POLLUTION AND CONTROL (09)

Fresh water and its pollution – Natural processes – sources and pollutants – pollution due to industrial, agricultural and municipal wastes – effects on streams - limitations of disposal by dilution – BOD consideration in streams – Oxygen Sag Curve – Strategies for sustainable water management – Marine environment and its management – Water acts.

UNIT – III AIR AND NOISE POLLUTION (09)

Pollutant emissions - sources and sink – effects of air pollution on human health, vegetation and climate– Global effects – prevention and control of air pollution – Control of particulates – Air pollution surveys and sampling – Air quality monitoring - Air Act – Management of air pollution – Sound level – Effect of noise on people – Environmental noise control- noise pollution rules, 2000.

UNIT – IV SOLID WASTE MANAGEMENT AND SOIL POLLUTION (09)

Sources – Characteristics – Quantities – Collection methods – Processing and disposal techniques – Onsite Handling, storage and processing – sanitary landfill – Incineration and pyrolysis – Composting – aerobic and anaerobic of compositing – Recycling and reuse of solid wastes – Hazardous wastes – Definition – Sources & types only – Integrated system for waste management – The Basel convention Land use and degradation – Management problems – strategies for sustainable land management – soil pollution –wetland conservation.

UNIT – V ENVIRONMENTAL MANAGEMENT SYSTEM (09)

Terminology – installation and common motives of EMS – Environmental standards – ISO 14000 (Series) – basic principles – Environmental Audit – Environmental Impact assessment - Trade rules and environmental protection– Practices for Waste Minimisation and Cleaner Production.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. N.K.Uberoi, ***"Environmental Management",*** *Excel Books, New Delhi (2006).*

2. *Rao*, ***"Air Pollution"****, Tata McGraw-Hill Education, 01-Jun-1988*

REFERENCE BOOKS:

1. *S.Vigneahwaran,M.Sundaravadivel and D.S.Chaudhary* ***,"Environmental Management"****, SCITECH*

Publications(India) Pvt.Ltd, Chennai & Hyderabad (2004).

2. Technobanoglous, ***"Environmental Management"****, McGraw Hill Book Company (2006).*

COURSE OUTCOME:

CO1: *Students exposed to know common issues related with environment.*

CO2: *Students able to know the sources, causes and effects of water pollution.*

CO3: *Able to attain knowledge related with air and noise pollution.*

CO4: *Able to understand the various management techniques of solid waste and soil Pollution.*

CO5: *Able to acquire knowledge on Environmental Management Systems.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	L					M						L	H		L
CO2	L	M			L		H					L	H	H	L	L
CO3	L	M			L		H					L	H	H	L	L
CO4	L	M			L		H					L	H	H	L	L
CO5	M	L					M						L	H	L	L
16COEX06	L	M			L		H					L	M	H	L	L

L-Low, M-Moderate(Medium), H-High

16MOEX07 TOWN PLANNING AND ARCHITECTURE CATEGORY:OE

(Common to All Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

* *Students are introduced the basics of Town Planning and Architecture*

UNIT – I TOWN PLANNING (09)

History of evolution of towns - Town and environment – Planning acts – land use classification – Transportation network - Climate, humidity, wind and radiation - Surveys and Data collection - Residential neighborhoods - Industrial areas - Public Buildings - Housing and Slum clearance.

UNIT – II BUILDING RULES AND GUIDELINES (09)

General – Zoning regulations – Regulations regarding layouts or subdivisions – Building regulations – Rules for special types of buildings – Floor space index – minimum plot size and building front age – Open spaces – Minimum standard dimensions of building elements – Provision for lighting and ventilation – Provision for means of access – Provision for urban growth.

UNIT – III BASIC ELEMENTS OF ARCHITECTURE (09)

Introduction of Architecture – Definition – Mass and space visual emotional effects of geometric forms and their derivatives – The sphere, the cube, the pyramid, the cylinder and cone – The aesthetic qualities of Architecture – Proportion, scale, balance, symmetry, rhythm and axis – contrast in form – Harmony – Consideration of comfort factors acoustics, lighting, ventilation and thermal aspects.

UNIT – IV PRINCIPLES OF ORIENTATION AND PLANNING OF BUILDINGS (09)

General – factors affecting orientation – sun – Wind – Rain – Orientation criteria for Indian conditions – Principles governing the theory of Planning – General requirements of site and building – Functional planning of buildings.

UNIT – V ELEMENTS OF INTERIOR DESIGN (09)

General – Decorative Materials – Cement Bonded Board (BISON PANEL), Water proof cement paint, Industrial glazing and Roofing, unit masonry, plaster and dry wall, Wall surface materials, Effect of colour on architecture – Home furnishing – plans in rooms.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. S.C.Rangwala, ***"Elements of Town Planning"****, McGraw Hill, London, 2006.*

2. *Biswas Hiranmay*, ***"Principles of Town Planning and Architecture"****, VAYU Education of India, 2012.*

REFERENCE BOOKS

1. V.S.Pramar, ***"Design fundamentals and architecture"*** *Lakshmi Publishers, 2003.*

2. Hiraskar, ***"Fundamentals in town planning"*** *Khanna Publishers, 2005.*

COURSE OUTCOME:

CO1: *Students will be able to know about the basics of town planning and building rules.*

CO2: *Students will be able to gain knowledge on building rules & regulations.*

CO3: *Students able to apply the architectural principles in the area of Civil Engineering.*

CO4: *Students will be able to do planning of various buildings.*

CO5: *Students will be able to understand about interior design of buildings.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1				M								L		L		
CO2							M				L	L				
CO3		L		L						M			L			
CO4		L		L						M						
CO5		M						L				H				
16COEX07		L		L			L	L		L	L	L	L	L		

L-Low, M-Moderate(Medium), H-High

16MOEX08 TOTAL QUALITY MANAGEMENT FOR ENGINEERS CATEGORY:OE

(Common to All Branches except Production)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES

* *To impart knowledge to develop a product with the required quality at a reasonable price and to satisfy the requirements under various quality standards*

UNIT - I QUALITY CONCEPTS (9)

Definition of quality, dimensions of quality, quality planning, quality costs concepts - basic concepts of total quality management, principles of TQM, leadership concepts - quality council, quality statements, strategic planning- steps in strategic planning- Deming philosophy, barriers in TQM implementation, benefits of TQM.

UNIT - II TQM PRINCIPLES (9)

Contribution of TQM Gurus - customer perception of quality - retention, employee involvement - motivation, empowerment, performance appraisal, continuous process improvement – Juran trilogy, PDSA cycle, 5S concept, kaizen, supplier partnership - supplier rating – performance measures- Malcom Balridge National Quality Award.

UNIT - III STATISTICAL PROCESS CONTROL (9)

Seven old and new tools of quality - statistical fundamentals - population and sample – normal curve - control charts for variables ,attributes and its applications - process capability - concept of six sigma.

UNIT - IV TOOLS AND TECHNIQUES (9)

Benchmarking needs and benefits - benchmarking process - quality function deployment (QFD) - house of quality - Taguchi quality loss function - total productive maintenance (TPM) - pillars of TPM - Failure Mode Effective Analysis (FMEA) - Failure rate - types of FMEA - stages of FMEA - case studies.

UNIT - V QUALITY SYSTEMS (9)

Introduction to ISO 9000 and other quality system - ISO 9001:2015 quality system – elements - implementation of quality system - documentation - quality auditing - QS 9000, ISO 14000 - concept, requirements and benefits - integrating ISO 14000 with ISO 9000 – OSHSAS 18001,Implementation of TQM in manufacturing industry.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. Dale H.Besterfield, et al., ***"Total Quality Management",*** *Pearson Education, 2008.*

2. Subburaj Ramasamy, ***"Total Quality Management",*** *Tata McGraw Hill, 2008.*

3.Vilas S.Bagad, "Total Quality Management", TECHNICAL PUBLICATIONS, 2017.

REFERENCE BOOKS

1. James R.Evans & William M.Lidsay, ***"The Management and Control of Quality",****Thomson Learning, 2002.*

2. Feigenbaum.A.V. ***"Total Quality Management",*** *McGraw-Hill, 1991.*

*3. Zeiri,****"Total Quality Management for Engineers"*** *Wood Head Publishers, 1991*

*4. P.N.Mukherjee****"Total Quality Management"****,PHI Publishers,2006*

5. John.L Hradesky ***"Total Quality Management Hand book"*** *McGraw-Hill, 1995.*

COURSE OUTCOMES

On completion of this course, students will be able to

- ***CO1:*** *Apply the principle of strategic planning, Deming philosophy and leadership concepts in industries.*
- ***CO2:*** *Apply the principle of TQM in industries.*
- ***CO3:*** *Apply the principle of statistical process control in industries.*
- ***CO4****: Select appropriate quality tools to meet industrial requirements.*
- ***CO5:*** *Implement appropriate quality standards for industries.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	H			M			L	L		L	L	M	L	M
CO2	L	H			M			L	L		L	L	M	L	M
CO3	L	H			M			L	L		L	L	M	L	M
CO4	L	H			M			L	L		L	L	M	L	M
CO5	L	H			M		L	L	L		L	L	M	L	M
16MOEX08	L	H			M		L	L	L		L	L	M	L	M

L-Low, M-Moderate(Medium), H-High

16MOEX09 **COMPOSITE MATERIALS** **CATEGORY:OE**

(Common to all Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MBS2Z3 Material Science

COURSE OBJECTIVES:

* *To impart the fundamentals of composite materials with different reinforcement, matrix materials and comprehend the types of manufacturing methods for advance composite materials to meet various engineering requirements.*

UNIT – I INTRODUCTION TO COMPOSITE MATERIALS (9)

Types and characteristics of composite materials - Mechanical behavior - Basic terminology and Manufacture of laminated fiber - Reinforced composite materials - Current and potential advantages - Applications of composite materials.

UNIT - II REINFORCEMENT AND MATRICES (9)

Different types of fibers - Properties and applications of fibers - Roll of matrix - Matrix materials, Selection of matrix - Thermoset matrix - Thermoplastic matrix, Fiber architecture – Natural Fibers.

UNIT – III DESIGN OF COMPOSITE STRUCTURES (9)

Elements of Design - Steps in design process - Elements of analysis in design - Analysis iterations - Design analysis stages - Material selection - Configuration selection - Laminate joints - Design requirements and design failure criteria.

UNIT – IV MANUFACTURING OF ADVANCED COMPOSITES (9)

Bag – Molding process - Compression molding – Pultrusion - Filament winding - Liquid composite molding processes - Resin film infusion-Elastic reservoir molding - Tube rolling - Forming methods for thermoplastic matrix composites.

UNIT - V METAL, CERAMIC AND CARBON MATRIX COMPOSITES (9)

Metal matrix composites - Manufacturing processes - Ceramic matrix composites - Mechanical properties - Manufacturing processes - Carbon matrix composites - Fabrication methods - Applications.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

*1. Krishnan K., Chawla **"Composite Materials Science and Engineering"**, Springer (India) Private Limited, 2011*

*2.P.K. Mallick , **"Fiber Reinforced Composite materials, Manufacturing and Design"**, CRC Press, Taylor and Francis Group, Boca Raton, London, Newyork 2010*

REFERENCE BOOKS

1. A.K.Bhargava, ***"Engineering Materials: Polymers, ceramics and composites"****, Pentice Hall of India Limited, 2010.*

2. Hyer M., Stress Analysis of Fiber – ***"Reinforced Composite Materials"****, Tata McGraw Hill, 1998.*

3. Madhujit Mukhopadhyay , ***"Mechanics of Composite Materials and Structures "****, Universities Press (India) Private Limited, 2009.*

4. Robert M.Jones, ***"Mechanics of Composite Materials"****, Taylor & Francis Group, 2010.*

5. Web Portal: Composite Materials {Nptel .Mechanical Engineering}

COURSE OUTCOMES:

On completion of this course, students will be able to

- **CO1***: Understand the mechanics and behaviour of reinforced composite materials for specific applications and developing composite materials for sustainability.*
- **CO2***: Formulate different types of reinforcement and matrices to develop new composite material for the various application.*
- **CO3***: Design and manufacture post processing methods of composite structures and capable to perform various analysis.*
- **CO4***: Execute different methods of manufacturing advanced composites to meet the innovate demand in engineering.*
- **CO5***: Fabricate metal matrix, ceramic matrix and carbon matrix composite for various engineering application to meet the societal demand.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	H			M	M				L		H		L
CO2	H	M	M	M	M		L				M		M	M	
CO3	M	M	M	M		L	M				L		L	M	
CO4	M	M	M	L		H	L		L		M		M	L	
CO5	L	L		L		M	L					L	M	M	
16MOEX09	M	M	M	L	L	M	L		L		L	L	M	L	L

L-Low, M-Moderate(Medium), H-High

16MOEX10 **AUTOMOBILE ENGINEERING** **CATEGORY:OE**

(Common to all Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES:

16MPC502 Thermal Engineering

16MPC603 Design of Transmission systems

COURSE OBJECTIVES:

- *The learners are able to visualize the scope of Automobile Engineering.*

UNIT - I INTRODUCTON TO AUTOMOTIVES (9)

An overview of different types of automobiles and their power sources. Specifications, Performance Parameters, Quality standards, Trends in automobile design

UNIT - II POWER SOURCE FEATURES (9)

Reciprocating Engine systems, Rotary Engine systems, Gas Turbine systems, Hybrid systems - Pollutant emissions and their control; Catalytic converter systems, Electronic Engine management systems

UNIT - III TRANSMISSION, SUSPENSION AND BRAKING SYSTEMS (9)

Clutch system, Gear box system, propeller shafting, differential, axles, wheels and tyres and Preliminaries of suspension systems

UNIT - IV AUXILIARY SYSTEMS (9)

Electrical and electronic systems, safety systems, Heating, Ventilation, and Air Conditioning (HVAC) systems, Vehicle Thermal Management System and vehicle body design features.

UNIT - V TESTS, SERVICE AND MAINTENANCE (9)

Engine Tuning, vehicle maintenance, engine and Chassis Dynamometry Pollutants and emissions Check, Wind Tunnel Tests, preliminaries of engine and vehicle testing.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

*1. Dr. Kirpal Singh, **"Automobile Engineering Vol. I & II"**, Standard Distributors Publishers, 2012.*

*2. R.B.Gupta, **"Automobile Engineering"** Sathya Prakashan, New Delhi, 2006.*

REFERENCE BOOKS

*1. William H.Crouse, **"Automotive Mechanics"**, McGraw Hill Book Co. 2004.*

*2. K.K. Ramalingam, **"Automobile Engineering – theory and Practice"** SciTech Publications, 2001.*

*3. Joseph Heinter **"Automobile Mechanics Principles and Practice"** Affiliated East West Press, 1997.*

*4. Jain K.K. and Asthana. R.B, **"Automobile Engineering"** Tata McGraw Hill Publishers, New Delhi, 2002.*

*5. Heinz Heisler, **"Advanced Engine Technology"** SAE International Publications USA, 1998.*

COURSE OUTCOMES:

On completion of this course, learners will be able to:

CO1: *Identify the different components in an automobile.*

CO2: *Clearly understand different auxiliary and transmission systems.*

CO3*: Explain the working of various parts like engine, transmission, clutch, brakes*

CO4*: Understand the environmental implications of automobile emissions*

CO5*: Develop a strong base for understanding future developments in the automobile industry*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	L	H	M	M	M	L	L	L	H	M	M	H
CO2	H	M	H	H	M	H	L	L	L	M	M	L	H	M	H
CO3	M	M	M	L	M	H	M	L	L	M	H	L	H	H	M
CO4	H	M	H	M	H	M	H	H	M	M	H	L	L	L	H
CO5	M	L	L	L	M	H	M		L	H	H	H	H	M	H
16MOEX10	M	M	M	M	H	H	M	L	L	M	M	M	M	M	H

L-Low, M-Moderate(Medium), H-High

16EOEX11 RENEWABLE ENERGY SOURCES AND TECHNOLOGY CATEGORY:OE

(Common to all Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVE:

* *To elucidate the technologies used for generation and utilization of power from renewable energy resources.*

UNIT - I SOLAR ENERGY (9)

Solar radiation, solar spectra-latitude and longitude, Declination angle, solar window, cosine law, seasonal variations, hour angle, calculation of angle of incidence, angstroms equation and constants, Photo voltaic: p-n junctions. Solar cells, PV systems, Standalone, Grid connected solar power - Types of solar thermal collectors – Flat and concentrating collectors, solar thermal applications -water heaters, dryers, stills, refrigeration, air-conditioning, solar pond, central receiver power generation.

UNIT - II WIND ENERGY (9)

Wind energy - Basic principle of wind energy conversion system, wind data and energy estimation, site selection, components of wind energy conversion systems, design consideration of horizontal axis wind mill- merits and limitations- application

UNIT - III BIOMASS ENERGY (9)

Biomass, sources of biomass, thermo-chemical and bio-chemical conversion of biomass - Pyrolysis, gasification, combustion and fermentation. Gasifiers – Up draft, downdraft and fluidized bed gasifier. Digesters - Fixed and floating digester biogas plants, economics of biomass power generation.

UNIT - IV OCEAN AND GEOTHERMAL ENERGY (9)

Ocean energy resources - Principles of ocean thermal energy conversion systems - ocean thermal power plants - Principles of ocean wave energy conversion and tidal energy conversion - Difference between tidal and wave power generation, Economics of OTEC.

Definition and classification of Geothermal resources, Utilization for electricity generation and direct heating, Wellhead power generating units. Overview of micro and mini hydel power generation

UNIT - V RENEWABLE ENERGY POLICIES (9)

Renewable energy policies - Feed-in tariffs, portfolio standards, policy targets, tax incentives, and biofuels mandates. International policies for climate change and energy security. Economic analysis and comparisons, Life cycle analysis, financial analysis, cost of conserved energy, and externalities. Cost assessment of supply technologies versus energy - Efficiency.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

1. Rao. S. and Dr. Pamlekar B.B, ***"Energy Technology",*** *Khanna Publishers, Second Ed. 1997*

2. Pai and Ramaprasad, ***"Power Generation through Renewal sources",*** *Tata McGraw Hill – 1991*

REFERENCE BOOKS:

1. Rai , G.D., ***"NonConventional sources of Energy****", Khanna Publishers , IV Ed.,2009*

2. Bansal NK, Kleeman and Meliss, M ***"Renewable Energy Sources and Conversion Techniques****", Tata McGraw Hill, 1996*

3. Roland Wengenmayr, Thomas Buhrke, ***"Renewable energy: Sustainable energy concepts for the future"****, Wiley-VCH, 1st edition, 2008.*

COURSE OUTCOME:

CO1: *Realize the need for utilizing the energy from clean and Sustainable energy resources.*

CO2: *Describe the principles of operation of the broad spectrum of renewable energy Technologies*

CO3: *Analyze energy technologies from a systems perspective.*

CO4: *Articulate the technical challenges for each of the renewable sources*

CO5: *Create solutions for alternate energy issues*

CO6: *Discuss economic, technical and sustainability issues involved in the integration of renewable energy systems*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	M	M	M			L	L	L	H	M	M
CO2	H	H	M	M	M	M	M	L		L	L	L	H	H	H
CO3	H	M	M	M	M	M	M	M			L	L	M	H	H
CO4	M	H	M	L	M	H	M	M		L	L	L	H	H	H
CO5	M	H	H	H	M	M	M	M		L	L	L	M	H	M
CO6	H	M	M	M	M	M	M		H	H	L	L	M	H	M
16EOEX11	H	H	M	M	M	M	M	L	L	L	L	L	H	H	H

L-Low, M-Moderate(Medium), H-High

16EOEX12 **SMART GRID TECHNOLOGY** **CATEGORY:OE**

(Common to all Branches)

	L	T	P	C
PRE-REQUISITES : *Nil*	3	0	0	3

COURSE OBJECTIVE:

* *To gain knowledge on the fundamentals of smart grid technologies, its architecture and its managements. Also the students should learn many of the challenges facing the smart grid as part of its evolution.*

UNIT - I SMARTGRIDS: MOTIVATION, STAKES AND PERSPECTIVES (9)

Introduction – Information and Communication technologies serving the electrical system – Integration of advanced technologies – Definitions of SmartGrids – Objectives addressed by the SmartGrid concept – Socio-economic and environmental objectives – Stakeholders involved the implementation of the Smart Grid concept – Research and scientific aspects of the Smart Grid – SmartGrids from the customer's point of view.

UNIT - II INFORMATION AND COMMUNICATION TECHNOLOGY (9)

Data Communication, Dedicated and shared communication channels, Layered architecture and protocols, Communication technology for smart grids, standards for information Exchange, Information security for the smart grid - Cyber Security Standards - IEEE1686 - IEC62351.

UNIT - III SENSING AND MEASUREMENT (9)

Synchro Phasor Technology – Phasor Measurement Unit, Smart metering and demand side integration - Communication infrastructure and protocol for smart metering – Data Concentrator, Meter Data Management System. Demand side Integration – Services, Implementation and Hardware Support of DSI.

UNIT - IV CONTROL AND AUTOMATION (9)

Distribution automation equipment – Substation automation equipments: current transformer, potential transformer, Intelligent Electronic Devices, Bay controller, Remote Terminal Unit. Distribution management systems – SCADA: modeling and analysis tools, applications

UNIT- V REGULATION OF SMARTGRIDS AND ENERGY STORAGE SYSTEMS (9)

Regulation and Economic models – Evolution of the value chain – The emergence of a business model for smart grids – Regulation can assist in the emergence of SmartGrids – The standardization of SmartGrids - Energy Storage Technologies - Methods - Batteries, Flow Battery, Fuel Cell and Hydrogen Electrolyser, Flywheel, Super - Conducting magnetic energy storage system, Super Capacitor.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, ***"Smart Grid Technologies and applications",*** *John Wiley Publishers Ltd., 2012*

2. Nouredine Hadjsaid, JeanClaude Sabonnadiere, ***"Smart Grids****", Wiley Publishers Ltd., 2012*

3. Lars T. Berger, Krzysztof Iniewski, ***"Smart Grid applications, Communications and Security",*** *John Wiley Publishers Ltd., 2012*

REFERENCE BOOKS :

1. Yang Xiao, ***"Communication and Networking in Smart Grids",*** *CRC Press Taylor and Francis Group, 2012.*

2. Caitlin G. Elsworth, ***"The Smart Grid and Electric Power Transmission"****, Nova Science Publishers Inc,August 2010*

COURSE OUTCOME:

CO1: *Develop and demonstrate the various aspects of the smart grid, including Technologies, Components, Architectures, Applications*

CO2: *Design a smart grid and to meet the needs of a utility, including Meeting a utility's objectives, helping to adopt new technologies into the grid*

CO3: *Creating a framework for knowledgeable power engineers to operate the grid more effectively*

CO4: *Transfer the available information from any part of the power system to centralized control centre.*

CO5: *Handle the smart meter, sensors and intelligent devices to measure the electrical quantity.*

CO6: *Control the Electrical quantity from remote place*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1				L	L	M	H	L	M	M	M	H	M	H	M
CO2	L	L	M	M	M	M	M	L	M	M	M	M	M	M	H
CO3				M	M	M	M	M	M	M	M	H	M	M	M
CO4	L			M	M	M	H		M	M	M	H	M	H	H
CO5	M		L	M	M	M	M		M	M	M	M	M	M	M
CO6	L	L	M	L	M	M	L		M	M	M	M	M	M	M
16EOEX12	L	L	L	M	M	M	M	L	M	M	M	H	M	M	M

L-Low, M-Moderate(Medium), H-High

16LOEX13 **PRINCIPLES OF COMMUNICATION** **CATEGORY:OE**

(Common to all Branches)

PRE-REQUISITES : *Nil*

L	T	P	C
3	0	0	3

***COURSE OBJECTIVES*:**

- *To understand the concepts of analog communication*
- *To gain the fundamental knowledge of digital communication*
- *To be familiar with the fundamentals of satellite and optical communication*

UNIT- I AMPLITUDE MODULATION (9)

Introduction to communication systems - Electromagnetic spectrum - Principle of amplitude modulation − AM envelope − frequency spectrum and bandwidth − modulation index and percentage of modulation − AM power distribution – AM generation and detection – square law modulator - envelope detector.

UNIT - II ANGLE MODULATION (9)

Frequency modulation and phase modulation - FM and PM waveforms − phase deviation and modulation index − frequency deviation and percentage of modulation − Frequency analysis of angle modulated waves - Bandwidth requirements for Angle modulated waves – generation and detection of FM – Armstrong modulator - Foster Seely Discriminator.

UNIT - III PULSE MODULATION (9)

Sampling and Quantization – Pulse Amplitude modulation - Pulse width modulation – Pulse position modulation - Pulse code modulation - PCM transmitter and receiver - Signal to Quantization noise ratio – Differential Pulse Code Modulation − Delta modulation − Adaptive Delta modulation

UNIT - IV DIGITAL COMMUNICATION (9)

Introduction – ASK, FSK,PSK - transmitter and receiver – QPSK transmitter and receiver – M ary PSK – Error probability in PSK, FSK.

UNIT -V SATELLITE AND OPTICAL COMMUNICATION (9)

Satellite Communication Systems - Transmitter and receiver - Kepler's Law – LEO and GEO Orbits – GEO Stationary orbit – Optical Communication Systems – Transmitter and receiver- Sources and Detectors- Types of Optical Fiber – Losses

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Wayne Tomas*i, "***Advanced Electronic Communication Systems",*** 6/e, Pearson Education, 2007.
2. *Simon Haykin, "**Communication Systems**", 4th Edition, John Wiley & Sons., 2008.*

REFERENCE BOOKS:

1. *H.Taub,D L Schilling ,G Saha ,"**Principles of Communication**"3/e,2007.*
2. *B.P.Lathi,"**Modern Analog And Digital Communication systems",** 3/e, Oxford University Press, 2007*
3. *Blake, "**Electronic Communication Systems",** Thomson Delmar Publications, 2002.*
4. *B.Sklar,"**Digital Communication Fundamentals and Applications" 2/e** Pearson Education 2007.*

COURSE OUTCOMES:

Upon completion of this course, the students will have the :

CO1. *Basic knowledge of amplitude modulation systems*

CO2. *Basic knowledge of angle modulation systems*

CO3. *Fundamental knowledge of digital communication systems*

CO4. *Understanding of digital transmission techniques*

CO5. *Fundamental knowledge of satellite communication system*

CO6. *Fundamental knowledge of optical communication system*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M									L	M	L	
CO2	M	M	M									L	M	L	
CO3	M	M	M									L	L	L	
CO4	M	M	M									L	M	L	
CO5	M	M	M									L	L	L	
CO6	M	M	M									L	M	M	
16LOEX13	M	M	M									L	M	L	

L-Low, M-Moderate(Medium), H-High

16LOEX14 MICROCONTROLLERS AND ITS APPLICATIONS CATEGORY:OE

(Common to all Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To gain knowledge on basics of microcontrollers*
- *To get exposure to programming of microcontroller 8051*
- *To acquire knowledge on interfacing of peripherals with 8051 and PIC microcontrollers*
- *To get exposure on applications of microcontrollers*

UNIT - I INTRODUCTION TO MICROCONTROLLER (9)

Microprocessors and Microcontrollers – CISC and RISC - Fundamentals of Assembly language Programming – Instruction to Assembler – C Programming for Microcontrollers – Compiler and IDE – Introduction to Embedded systems - Architecture 8051 family - PIC 18FXXX – family – Memory organization

UNIT - II PROGRAMMING OF 8051 MICROCONTROLLER (9)

Instruction set – Addressing modes – I/O Programming - Timer/Counter - Interrupts – Serial communication of 8051.

UNIT - III PROGRAMMING OF PIC18FXXX MICROCONTROLLER (9)

Instruction set – Addressing modes – I/O Programming - Timer/Counter - Interrupts – Serial communication, CCP, ECCP PWM programming of PIC18FXXX.

UNIT - IV PERIPHERAL INTERFACING (9)

Interfacing of Relays, Memory, key board, Displays – Alphanumeric and Graphic, RTC, ADC and DAC, Stepper motors and DC Motors, I^2C, SPI with 8051 and PIC family.

UNIT - V MICROCONTROLLER APPLICATIONS (9)

Pulse measurement - measuring frequency, pulse width measurement - Speed control of DC Motor - Speed control of Stepper Motor - Traffic Light Controller and Washing Machine Controller.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

1. Kenneth J.Ayala., **"The 8051 Microcontroller",** 3rd Edition, Thompson Delmar Learning, 2007, New Delhi.

2. John B. Peatman, "**PIC programming"**, McGraw Hill International, USA, 2005.

REFERENCE BOOKS:

1.Muhammad Ali Mazidi and Janice GillispicMazdi, "**The 8051 Microcontroller and Embedded Systems**" Pearson Education, Inc 2006.

2.John B. Peatman, "**Design with Micro controllers"**, McGraw Hill International, USA, 2005

3.James W. Stewart, **"The 8051 Micro controller hardware, software and interfacing**", regents Prentice Hall, 2003.

4.David Calcutt, Fred Cowan, Hassan Parchizadeh, "**8051 Microcontroller An Application Based Introduction"**, Elsevier Publication, 1st edition,2004.

5.Krishna Kant, "**Microprocessor and Microcontrollers**" Eastern company edition, Prentice Hall of India, New Delhi, 2007.

COURSE OUTCOMES:

Upon completion of this course the student will:

CO 1: *Acquire knowledge on the basics of microcontroller.*

CO 2: *Exposure to 8051 microcontroller Programming.*

CO 3*: Exposure to PIC microcontroller Programming.*

CO 4: *Able to interface peripherals with microcontrollers.*

CO 5*: Get exposure to the applications of microcontrollers.*

CO 6: *Able to design microcontroller based systems.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	M									L	L	L	
CO2	M	H	M									M	M	M	
CO3	M	H	M									M	M	M	
CO4	M	H	M									M	M	M	
CO5	M	H	M									M	M	M	
CO6	H	H	H									M	H	H	
16LOEX14	M	H	M									M	M	M	

L-Low, M-Moderate(Medium), H-High

16NOEX15 INDUSTRIAL AUTOMATION SYSTEMS CATEGORY: OE

(Common to all Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES

- *To elaborate the basic concept of automation and the components required for automation.*
- *To introduce the concept and programming of programmable logic controllers and distributed control system which is used for process automation.*
- *To outline the basic concepts of SCADA technology.*

UNIT - I INTRODUCTION TO AUTOMATION (9)

Automation overview – requirement of automation systems – architecture of industrial automation system – power supplies and isolators –relays – switches –transducers – sensors –seal-in circuits – industrial bus systems : modbus and profibus.

UNIT - II AUTOMATION COMPONENTS (9)

Sensors for temperature – pressure – force – displacement - speed – flow- level – humidity and pH measurement. Actuators – process control valves – power electronic drives DIAC- TRIAC – power MOSFET – IGBT. Introduction to DC and AC servo drives for motion control

UNIT- III PROGRAMMABLE LOGIC CONTROLLERS (9)

PLC Hardware – PLC programming – ladder diagram – sequential flow chart – PLC communication and networking – PLC selection – PLC installation – Advantages – Application of PLC to process control industries and Robotics.

UNIT - IV DISTRIBUTED CONTROL SYSTEM (DCS) (9)

Overview of DCS – DCS hardware – DCS software configuration – DCS communication – DCS supervisory computer tasks – DCS integration with PLC and Computers

UNIT - V SCADA (9)

Introduction - Supervisory Control and Data Acquisition Systems (SCADA) – SCADA HMI Essentials – SCADA Components – SCADA Configuration and Software – HMI hardware and software.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. *John.W. Webb Ronald A Reis, "**Programmable Logic Controllers - Principles and Applications**", Prentice Hall Inc., 5th Edition, 2003.*
2. *M. P. Lukcas, "**Distributed Control Systems",** Van Nostrand Reinhold Co., 1986.*

REFERENCE BOOKS

1. *Bela G Liptak,* ***"Process software and digital networks – Volume 3",*** *4th Edition, CRC press, 2012.*

*2. Frank D. Petruzella, "****Programmable Logic Controllers****", 5th Edition, McGraw Hill, 2016.*

*3. Huges T, "****Programmable Logic Controllers****", ISA press, 1994*

*4. Romily Bowden, "****HART application guide and the OSI communication foundation****", 1999*

*5. Krishna Kant, "****Computer Based Industrial Control****" Second edition, Prentice Hall of India, New Delhi, 2010*

COURSE OUTCOMES:

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

CO1: *Elaborate the basic architecture of automation systems*

CO2: *Describe the various sensors and actuators involved in industrial automation*

CO3: *Construct ladder logic diagram using PLC basic functions, timer and counter functions for simple applications*

CO4: *Illustrate the functionary components and supervisory control of DCS with relevant diagrams.*

CO5*: Describe the basics of SCADA technology*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L
CO2	H	H	H	H	L	L	L	H	L	M	L	L	H	L	L
CO3	H	H	M	M	L	L	M	H	L	M	L	L	H	L	L
CO4	H	H	H	H	L	L	L	H	L	M	L	L	H	L	L
CO5	H	H	M	M	M	L	L	H	L	M	L	L	H	L	L
16NOEX15	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L

L-Low, M-Moderate(Medium), H-High

16NOEX16 MEASUREMENTS AND INSTRUMENTATION CATEGORY:OE

(Common to all Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES

- *To study about the electrical parameter measuring instruments.*
- *To familiarize about the measurement techniques for power and energy.*
- *To gain knowledge about potentiometer and instrument transformers.*
- *To learn about the working of different analog and digital instruments.*
- *To study about display and recording devices.*

UNIT - I MEASUREMENT OF ELECTRICAL PARAMETERS (9)

Types of ammeters and voltmeters: PMMC Instruments, Moving Iron Instruments, Dynamometer type Instruments – Resistance measurement: Wheatstone bridge, Kelvin double bridge and Direct deflection methods. Measurement of Inductance: Maxwell-Wien Bridge, Hay's bridge and Anderson Bridge - Measurement of Capacitance: Schering Bridge.

UNIT - II POWER AND ENERGY MEASUREMENTS (9)

Electro-dynamic type wattmeter: Theory and its errors – LPF wattmeter – Phantom loading – Single phase Induction type energy meter – 3 phase induction energy meter and phase measurement – Calibration of wattmeter and Energy meters – Synchroscope.

UNIT - III POTENTIOMETERS AND INSTRUMENT TRANSFORMERS (9)

D.C. Potentiometers: Student type potentiometer, Precision potentiometer – A.C. Potentiometers: Polar and Coordinate types – Applications – Instrument Transformer: Construction and theory of Current Transformers and Potential Transformers.

UNIT - IV ANALOG AND DIGITAL INSTRUMENTS (9)

Wave analyzers – Signal and function generators – Distortion factor meter – Q meter – Digital voltmeter and multi-meter – Microprocessor based DMM with auto ranging and self diagnostic features – Frequency measurement.

UNIT - V DISPLAY AND RECORDING DEVICES (9)

Cathode ray oscilloscope: Classification, Sampling and storage scopes – LED, LCD and dot matrix displays – X-Y recorders – Magnetic tape recorders – Digital Data Recording – Digital memory waveform recorder – Data loggers.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1.Kalsi. H.S, "***Electronic Instrumentation***", Tata McGraw-Hill, New Delhi, 2010

2.Sawhney.A.K, "***A Course in Electrical & Electronic Measurements & Instrumentation***", Dhanpat Rai and Co., New Delhi, 2010

REFERENCE BOOKS

1.Northrop. R.B, *"**Introduction to Instrumentation and Measurements**",* Taylor & Francis, New Delhi, 2008.

2.Carr.J.J, *"**Elements of Electronic Instrumentation and Measurement**",* Pearson Education India, New Delhi, 2011.

3.David A.Bell, *"**Electronic Instrumentation and Measurements**",* PHI, New Delhi.

4.Copper. W.D and Hlefrick.. A.D, "***Modern Electronic Instrumentation and Measurement Technique"*** 5th Edition, Prentice Hall of India, 2002.

COURSE OUTCOMES:

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

CO1: *Compare the working principles, merits and demerits of different types of electrical instruments and can understand about different instruments that are used for Measurement purpose.*

CO2: *Understand how different bridge networks are constructed and balanced for finding the values of resistance, capacitance and inductance.*

CO3*: Apply knowledge of electronic instrumentation for measurement of electrical quantities.*

CO4: *Apply the principles and practices for instrument design and development to real world problems.*

CO5: *Select a suitable measuring instrument for a given application.*

CO6: *Pursue higher studies and do research activities in the field of measurement and instrumentation.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	H	M	H	M	L	H	M	H	H	H	M	H
CO2	H	M	M	M	H	H	H	M	H	L	H	H	H	H	M
CO3	H	H	M	H	M	H	M	L	H	M	H	H	H	H	H
CO4	H	H	M	H	M	H	M	L	H	M	H	H	H	M	H
CO5	H	H	M	H	M	H	M	L	H	M	H	H	H	M	M
CO6	H	H	M	H	M	H	M	L	H	M	H	H	M	H	M
16NOEX16	H	H	M	H	M	H	M	L	H	M	H	H	H	H	H

L-Low, M-Moderate(Medium), H-High

16SOEX17 **ENTERPRISE JAVA** **CATEGORY:OE**

(Common to all Branches)

PRE-REQUISITES : *Nil*

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

Upon completion of this course, the students will be familiar with:

- *Basic programming constructs in java to develop simple object oriented programs*
- *Enterprise Architecture types and features of Java EE platform*
- *JEE foundation concepts like Enterprise java bean,JSP and JSF*
- *Distributed Programs and methods to connect with database.*
- *Java Web services*

UNIT- I INTRODUCTION TO JAVA (9)

Introduction to object oriented programming-Features of Java – Data types, variables and arrays – Operators – Control statements – Classes and Methods – Inheritance. Packages and Interfaces – Exception Handling – Multithreaded Programming – Input/Output – Files – Utility Classes – String Handling – Networking – Applet class – Event Handling.

UNIT -II INTRODUCTION TO ENTERPRISE JAVA (9)

Challenges of Enterprise application Development - Platform for enterprise Solutions – J2EE Application Scenario - J2EE Platform Technologies – J2EE Multi-Tier Architecture - J2EE Architecture Approaches - Model-View-Controller Architecture - J2EE Design Patterns - Designing the Sample Application - Choosing Application Tiers - Choosing Local or Distributed Architecture - Architecture of the Sample Application

UNIT- III ENTERPRISE JAVA FOUNDATION (9)

Enterprise Java Beans -Business Logic and Business Objects - Enterprise Beans as J2EE Business Objects - Entity Beans - Session Beans - Message-Driven Beans -Transaction support in EJB- Security support in EJB – Java Server Pages - Directive Elements - Scripting Elements - Action Elements - Expression Language - JSP Standard Tag Library - Java Server Page Online Store – Java Server Faces - Life Cycle - Resource Management.

UNIT -IV INTERCONNECTIVITY (9)

Concept of JDBC – JDBC Driver types- Database Connection – Associating JDBC Bridge with the database – Statement Objects – Resultset – Transaction Processing – RMI - Network File-Locking Server - Java Mail API and Java Activation Framework – send, receive, retrieve and delete email message - Java Message Service – JMS Fundamentals – Components of a JMS program - JMS architecture – JMS - Based Alarm System - JNDI – Naming and Directories – Naming Operations

UNIT -V WEB SERVICES (9)

SOAP Basics – Java API for XML Messaging – Creating a SOAP Attachment – Accessing a SOAP Attachment – Universal Description, Discovery and Integration (UDDI) - UDDI Architecture – UDDI Application Programming Interface – Inquiry Application Programming Interface – Publishing Application Programming Interface –JAXR – JAXR client – Publishing a service to an XML Registry – Removing a published service from an XML Registry- WSDL – Inside WSDL - WSDL and SOAP - RESTFul Web services – REST Approach - Java API for RESTful Web service.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. Herbert Schildt, "**Java The Complete Reference**" , 9th Edition, Tata Mc Graw- Hill Edition. 2014.
2. Stephen Asbury and Scott R. Weiner "**Developing Java Enterprise Applications",** second edition Wiley Publishing.1999.
3. Antonio Goncalves "**Beginning Java™ EE 6 Platform with GlassFish™ 3From Novice to Professional**" Apress 2009.
4. Jim Keogh, "**The Complete Reference J2EE**", Tata McGraw –Hill 2002

REFERENCE BOOKS

1. John Brock,Arun Gupta,GeertjanWielenga "**Java Server Programming Java EE 7 (J2EE 1.7) - Black Book**" McGraw Hill, 2015.
2. Inderjeet Singh, Beth Stearns, Mark Johnson, and the Enterprise Team "**Designing Enterprise Applications with the J2EE™ Platform**", Second Edition Addison Wesley, 2002.

COURSE OUTCOMES

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

CO1: Write simple java programs using fundamental concepts of java like control structures, inheritance, packages,interfaces,multithreaded programming and exception handling**.** ***[Usage]***

CO2: Write java program for Networking using applets**.*** *[Usage]*

CO3: Describe and use the client/server and distributed architectures in a programming environment**.** ***[Usage]***

CO4: Use EJB, JSP and JFC technology in developing enterprise applications ***[Usage]***

CO5: Apply Java interconnectivity techniques like JDBC, RMI, Java Mail, JMS , JNDI in developing enterprise applications**.** ***[Usage]***

CO6: Explain the roles XML,JAXR, SOAP, WSDL and UDDI in the architecture of Web services ***[Familiarity]***

CO7**:** Develop java program to use RESTful web services ***[Assessment]***.

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PO 1
CO1	L	L	M					L				L				
CO2	L	L	M	L	H			L				L	L	H		L
CO3	L	L	M	L	H			L				M	L	H	H	L
CO4	L	L	M	L	H	L	L	L	L	L	L	M	L	H	H	L
CO5	L	L	M	L	H			L				M	L	H		L
CO6		L	L									L		H	H	H
CO7	L	L	L	L	H			L	L	L	L	M	L	H	H	H
16SOEX17	L	L	M	L	L	L	L	L	L	L	L	M	L	H	M	L

L-Low, M-Moderate(Medium), H-High

16SOEX18 **CYBER SECURITY** **CATEGORY:OE**

(Common to all Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with:

- *Cybercrime and cyber offenses.*
- *Cybercrime using mobile devices.*
- *Tools and methods used in cybercrime.*
- *Legal perspectives of cybercrime.*
- *Fundamentals of computer forensics.*

UNIT- I INTRODUCTION TO CYBERCRIME AND CYBEROFFENSES (9)

Cybercrime and Information Security - Classifications of Cybercrimes - The Legal Perspectives - Cybercrime and the Indian ITA 2000 - A Global Perspective on Cybercrimes - Plan of Attacks - Social Engineering – Cyberstalking - Cybercafe and Cybercrimes – Botnets - Attack Vector.

UNIT- II CYBERCRIME: MOBILE AND WIRELESS DEVICES (9)

Proliferation of Mobile and Wireless Devices - Trends in Mobility - Credit Card Frauds in Mobile and Wireless Computing Era – Security challenges posed by mobile devices – registry setting for mobile devices – authentication service security – attacks on mobile/cell phones – Organizational measures for handling mobiles.

UNIT -III TOOLS AND METHODS USED IN CYBERCRIME (9)

Proxy Servers and Anonymizers – Phishing - Password Cracking – Keyloggers – Spywares -Virus and Worms - Trojan Horses and Backdoors – Steganography - DoS and DDoS Attacks - SQL Injection - Attacks on Wireless Networks.

UNIT -IV CYBERCRIMES AND CYBERSECURITY: THE LEGAL PERSPECTIVES (9)

Cyberlaws- The Indian Context - The Indian IT Act - Challenges to Indian Law and Cybercrime Scenario in India - Consequences of Not Addressing the Weakness in Information Technology Act - Digital Signatures and the Indian IT Act - Amendments to the Indian IT Act - Cybercrime and Punishment.

UNIT -V UNDERSTANDING COMPUTER FORENSICS (9)

Digital Forensics - Forensics Analysis of E-Mail - Network Forensics - Forensics and Steganography - Forensics and Social Networking Sites - Challenges in Computer Forensics - Data Privacy Issues – Forensics Auditing – Antiforensics

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOK

1.Nina Godbole and Sunit Belapur, **"Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives"**, Wiley India Publications, April, 2011.

REFERENCE BOOKS

1.Robert Jones, **"Internet Forensics: Using Digital Evidence to Solve Computer Crime",** O'Reilly Media, October, 2005.

2.Chad Steel, **"Windows Forensics: The field guide for conducting corporate computer investigations"**, Wiley India Publications, December, 2006.

COURSE OUTCOMES:

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

CO1:*Explain the fundamental concepts of cybercrime and cyberoffenses.* ***[Familiarity]***

CO2*:Describe the cybercrimes occurred in mobile and wireless devices.* ***[Familiarity]***

CO3*:Elaborate the methods used in cybercrime.* ***[Familiarity]***

CO4*:Explain the laws for cybercrime and its respective punishments.* ***[Familiarity]***

CO5*:Explain the forensics Analysis of E-Mail, Network and Social Networking Sites.* ***[Familiarity]***

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L	L	L	M	L	H						L	L	L	H	L
CO2	L	L	L	M	L	H						L	L	L	H	L
CO3	L	L	L	M	L	H						L	L	L	H	L
CO4	L	L	L	M	L	H						L	L	L	H	L
CO5	L	L	L	M	L	H						L	L	L	H	L
16SOEX18	L	L	L	M	L	H						L	L	L	H	L

L-Low, M-Moderate(Medium), H-High

16SOEX19 **NETWORK ESSENTIALS** **CATEGORY:OE**

(Common to all Branches)

	L	T	P	C
PRE-REQUISITES : *Nil*	3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with:

- *Basic taxonomy and terminology of the computer networking*
- *Wireless networking*
- *Addressing and Routing*
- *Routing protocols*
- *Troubleshooting and security issues.*

UNIT -I INTRODUCTION (9)

Introduction to Computer Networks - Goals and advantages of Computer Networks - Network Topologies – Basic networking devices – Protocols – the need for a layered architecture - The OSI Model and the TCP/IP reference model – the Ethernet LAN – Home Networking – Assembling an office LAN – Testing and Troubleshooting a LAN – Physical layer cabling: Twisted pair and Fiber optics

UNIT -II WIRELESS NETWORKING (9)

Importance of Wireless Networking – IEEE 802.11 Wireless LANs – Bluetooth - WIMAX – RFIDs – Securing the Wireless LANs – Configuring a Point to Multipoint Wireless LAN – Interconnecting network LANs – Switch, Bridges and Routers. Interconnecting LANs with the router, Configuring the network interface-Auto negotiation.

UNIT -III ADDRESSING AND ROUTING FUNDAMENTALS (9)

IPv4 and IPv6 addressing – Subnet masks – CIDR blocks – configuration of a router – Console port connection - user EXEC mode – Privileged EXEC mode - Configuration of a switch – Static VLAN configuration - Spanning Tree protocol – Network Management – Power over Ethernet.

UNIT- IV ROUTING PROTOCOLS (9)

Static Vs Dynamic Routing Protocols – Distance vector Routing – Link State Routing – Hybrid Routing – Configuring RIP - Network Services – DHCP, DNS - Analyzing Internet Traffic.

UNIT -V TROUBLESHOOTING AND NETWORK SECURITY (9)

Analyzing Computer Networks – FTP data packets – Analyzing Campus Network data traffic – Troubleshooting the router and switch interface, Troubleshooting fiber optics – Intrusion – DOS – Security software and hardware.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

*1.Jeffrey S.Beasley Piyasat Nilkaew, "**Network Essentials**", 3rd Edition, Pearson, 2012.*

*2.Larry L. Peterson and Bruce S. Davie, "**Computer Networks, A Systems Approach**", Morgan Kaufmann Publishers Inc, 5th edition 2011.*

REFERENCE BOOKS

*1.Behrouz A.Ferouzan,**"Data Communications and Networking"**, 5th edition, Tata McGraw-Hill, 2012.*

*2.Andrew S. Tanenbaum, "**Computer networks**"s, PHI, 5th edition 2011.*

*3.William Stallings, "**Data and computer communication**", 10th edition, Pearson Education, 2013.*

COURSE OUTCOMES

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

- ***CO1:*** *Identify topologies and types of Computer Networks **[Familiarity]***
- ***CO2:*** *Enumerate the layers of the OSI model and TCP/IP and Explain the functions of each layer **[Familiarity]***
- ***CO3:*** *Identify and Compare types of cabling for data communication **[Usage]***
- ***CO4:*** *Explain the significance of wireless networks **[Familiarity]***
- ***CO5:*** *Configure a Wireless LAN **[Assessment]***
- ***CO6:*** *Configure router and a switch **[Assessment]***
- ***CO7:*** *Describe basic routing algorithms and network services. **[Usage]***
- ***CO8:*** *Troubleshoot the router and switch interface **[Usage]***
- *CO9: Analyze Campus Network data traffic **[Usage]***

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	H	H	H	H				H	H	H	H	M	H	H	M
CO2	H	H	H	H	H				H	H	H	H	M	H	H	M
CO3	L	L	L	L	H				L	L	L	H	M	H	H	M
CO4	L	H	M		H				H	M	L	H	L	H	H	L
CO5	H	H	H	M	H				H	H	M	H	M	H	H	M
CO6	H	H	H	M	H				H	M	L	H	M	H	H	M
CO7	H	H	H	H	H				H	H	M	H	M	H	H	M
CO8	H	H	H	M	H				H	M	L	H	M	H	H	M
CO9	H	H	H	M	H				H	H	M	H	M	H	H	M
16SOEX19	M	H	H	M	H				H	M	M	H	M	H	H	M

L-Low, M-Moderate(Medium), H-High

16IOEX20 **PROGRAMMING IN PYTHON** **CATEGORY:OE**

(Common to all Branches)

	L	T	P	C
PRE-REQUISITES : *Nil*	3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course the students will be Familiar with:

- Data types and variables declaration
- Control statements, Functions and the use of basic programming.
- List, dictionary and functions used in python.
- File and Exception handling.
- Object oriented programming and GUI development.

UNIT -I INTRODUCTION (9)

Introduction to Python - Setting up Python in OS – Python IDLE (write – edit – run - and save programs) – Strings - Numbers – Variables – simple I/O - Getting user input – Using String method – Converting values.

UNIT -II CONTROL STATEMENTS AND FUNCTIONS (9)

Control statements – Random number generator - Branching and loops – Range functions - Functions – User defined functions - passing parameters - return function – working with global variables and constants.

UNIT -III LISTS AND DICTIONARIES (9)

Lists – create – index - slice a list - Add and delete elements from a list- Append - Sort and reverse a list - nested sequences- Dictionaries – Create – add - delete from a Dictionary - Operations associated with pairs of data.

UNIT -IV FILES AND EXCEPTIONS (9)

Files – Read from text files - Write to text files - Read and write more complex data - Exceptions – Intercept and handle errors during program's execution.

UNIT -V OBJECT ORIENTED PROGRAMMING AND GUI (9)

Object oriented programming – Create objects of different classes in the same program - objects communication - complex object creation - derive new classes - existing class extension - override method - GUI – GUI toolkit - create and fill frames - create buttons - text entries and text boxes - create check buttons and radio buttons - case study – create a web page using GUI functionality

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1.*Y. Daniel Liang* ***"Introduction to Programming Using Python",*** *Pearson, 2013.*

2.*Charles Dierbach* ***"Introduction to Computer Science Using Python: A Computational Problem-Solving Focus"****, Wiley Publications, 2012.*

REFERENCE BOOKS

1.*Michael Dawson "**Python Programming for the Absolute Beginner"**, Premier Press, 2003.*

COURSE OUTCOMES

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

CO1:** Use various data types.**[Understand]

CO2:**Handle the arrangement of data elements in Lists and Dictionary structures.**[Analyze]

CO3:** Use control statements and functions. **[Understand]

CO4:** Handle exceptions and perform file operations**. [Understand]

CO5:** Develop application using object oriented programming and GUI. **[Analyze]

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	M	L		L	L		L	L			L		L	L
CO2	M	L		L	L		L	L			L		L	L
CO3	M	M	L	M	L		L	L			L		M	L
CO4	M	M	L	M	L		M	M			L		M	L
CO5	M	M	L	M	L		M	M			M	L	M	L
16IOEX20	M	M	L	M	L		L	L			L	L	M	L

L-Low, M-Moderate(Medium), H-High

16IOEX21 **BIG DATA SCIENCE** **CATEGORY:OE**

(Common to all Branches)

PRE-REQUISITES : *Nil*

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- *Big Data and its characteristics*
- *Technologies used for Big Data Storage and Analysis*
- *Mining larger data streams*
- *Concepts related to Link analysis and handle frequent data sets*

UNIT- I THE FUNDAMENTALS OF BIG DATA (9)

Understanding Big Data - Concepts and Technology - Big Data Characteristics - Types of data - Case Study-Business Motivation and Drivers for Big Data Adoption- Planning Considerations-Enterprise Technologies and Big Data Business Intelligence – OLTP-OLAP - Extract Transform Load - Data Warehouses - Data Mart - Traditional and Big Data BI - Case Study

UNIT -II BIG DATA STORAGE AND PROCESSING (9)

Big Data Storage Concepts - Clusters - File systems and Distributed File Systems – NoSQL - Sharding – Replication - Sharding and Replication - CAP Theorem – ACID – BASE - Case Study - Big Data Processing Concepts - Parallel Data Processing - Distributed Data Processing – Hadoop - Processing Workloads – Cluster - Processing in Batch mode - Processing in RealTime mode - Case study

UNIT -III BIG DATA STORAGE AND ANALYSIS TECHNOLOGY (9)

Big Data Storage Technology: On-Disk Storage devices - NoSQL Databases-In-Memory Storage Devices - Case study, Big Data Analysis Techniques: Quantitative Analysis - Qualitative Analysis - Data Mining - Statistical Analysis - Machine Learning - Semantic Analysis - Visual Analysis - Case Study

UNIT -IV MINING DATA STREAMS (9)

The stream data model – Sampling data streams – counting distinct elements in a stream – Estimating moments. Finding similar items – Applications of nearest neighbor search – shingling of documents - similarity preservation – locality sensitive hashing - distance measures – methods for high degree similarity.

UNIT -V LINK ANALYSIS AND FREQUENT ITEMSETS (9)

Link analysis – Page rank – Efficient computation of a page rank – topic sensitive page rank – link spam –Frequent datasets – the market basket model – A-Priori algorithm – handling larger datasets in main memory –limited pass algorithm – counting frequent items in a stream

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1.Thomas Erl, WajidKhattak, and Paul Buhler," ***Big Data Fundamentals Concepts, Drivers & Techniques"****, Prentice Hall,2015*

2.AnandRajaraman and Jeffrey David Ullman, ***"Mining of Massive Datasets****", Cambridge University Press, 2012.*

REFERENCE BOOKS

1.Paul Zikopoulos, Chris Eaton, ***"Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data"****, McGraw Hill, 2011.*

2.Frank J Ohlhorst, ***"Big Data Analytics: Turning Big Data into Big Money",*** *Wiley and SAS Business Series, 2012.*

COURSE OUTCOMES

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

CO1:*Understand the Big Data and usage in Enterprise Technologies. [Understand]*

CO2:*Store and Process Big Data using suitable Processing Methods[Understand]*

CO3:*Handle Big Data using appropriate analysis Techniques. [Analyse]*

CO4:*Mine larger data streams using suitable algorithms. [Understand]*

CO5:*Rank pages and handle large data sets efficiently [Analyse]*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	H	L	M	L	H	L							H	L
CO2	M				H			L					M	L
CO3		H			H								H	
CO4	M	H	M		M								H	
CO5	L	M	H										H	
16IOEX21	M	M	L	L	M	L		L					H	L

L-Low, M-Moderate(Medium), H-High

16IOEX22 OBJECT ORIENTED PROGRAMMING USING C++ CATEGORY:OE

(Common to all Branches)

	L	T	P	C
PRE-REQUISITES : *Nil*	3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- *Fundamentals of object oriented programming*
- *Classes and objects*
- *Concepts of overloading and type conversions*
- *Inheritance and Polymorphisms*
- *Files, templates and exception handling*

UNIT -I PRINCIPLES OF OBJECT ORIENTED PROGRAMMING (9)

Basic concepts- benefits – applications of object oriented programming – beginning with C++ - tokens – expressions and control structures – C++ stream classes – Formatted and Unformatted I/O operations. Managing output with manipulators.

UNIT -II CLASSES AND OBJECTS (9)

Introduction – specifying class – defining member functions – memory allocation constructors and destructors:- parameterized- copy – default -dynamic and multiple constructors – destructors

UNIT -III FUNCTIONS AND TYPE CONVERSIONS (9)

Introduction – function prototyping call by reference – return by reference – inline function – recursion – friend function – function overloading – operator overloading – manipulation of strings using operators – type conversions

UNIT -IV INHERITANCE AND POLYMORPHISM (9)

Defining derived classes – single, multiple, multilevel, hierarchical and hybrid inheritance – virtual base classes – abstract base classes – nesting of classes - pointers – pointers to objects – this pointer – pointers to derived classes – virtual functions – pure virtual functions virtual constructors and destructors.

UNIT -V FILES AND TEMPLATES (9)

Classes for file stream operations – opening and closing a file – detecting EOF – open file modes – file pointers and their manipulations – sequential I/O operations – updating and error handling of file. Class and function template – template with multiple parameters – overloading, member function and non-type template arguments-Exception handling.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1.E.Balagurusamy ***"Object oriented Programming with C++"*** *McGraw Hill Education Ltd,6th Edition 2013.*

REFERENCE BOOKS

1.*R.Rajaram* ***"Object Oriented Programming and C++"*** *New Age International 2nd edition , 2013*

2.K.R. Venugopal,Rajkumar,T. Ravishankar ***"Mastering C++"*** *, Tata McGraw Hill Education,2nd edition, 2013*

3.Yashavant P. Kanetkar ***" Let us C++"*** *BPB Publications , 2nd edition 2003.*

COURSE OUTCOMES

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

CO1*:Understand the principles of object oriented programming [Understand]*

CO2*: Develop programs using classes and objects.[Analyze]*

CO3*: Use functions and type conversions in programs. [Understand]*

CO4*: Apply inheritance and polymorphism to develop applications. [Analyze]*

CO5*: Use files, templates and handle exceptions. [Understand]*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	M	H	H	M	M		M	M			M		M	M
CO2	M	H	H	H	M		M	M			M		H	M
CO3	M	H	H	H	M		M	M			M		H	M
CO4	M	H	H	H	M	L	M	M			M		H	M
CO5	M	H	H	H	M		M	M			M		H	M
16IOEX22	M	H	H	H	M	L	M	M			M		H	M

L-Low, M-Moderate(Medium), H-High

16BOEX23 **COMPUTATIONAL BIOLOGY** **CATEGORY:OE**

(Common to all Branches)

	L	T	P	C
PRE-REQUISITES : *Nil*	3	0	0	3

COURSE OBJECTIVES:

- *Understand the basic concepts and role of computation in biological analysis*
- *Familiarize with sequence alignment methods*
- *Understand the machine learning tools used for biological analysis*

UNIT -I BASICS OF BIOLOGY (9)

Biomolecules of life: Structure and Composition of DNA, RNA & Protein. Protein Structure basics-Primary, Secondary and tertiary Structure of protein

UNIT -II BIOLOGICAL DATABASES (9)

Concept of Relational database, Data archiving, Data mining, Primary databases-NCBI,EMBL,DDBJ; Structure databases - PDB

UNIT -III SEQUENCE ANALYSIS (9)

Pairwise alignment tools - Dot matrix analysis, Dynamic programming-Smith waterman and Needleman wunsch algorithm, Heuristic methods - BLAST,FASTA; Multiple sequence alignment methods - Progressive alignment (Clustal)

UNIT -IV STRUCTURE ANALYSIS AND DRUG DESIGN (9)

Protein secondary prediction - Chou fasman method, GOR method; Tertiary structure prediction - Homology modelling, Introduction to Computer aided drug design.

UNIT -V MACHINE LEARNING (9)

Genetic Algorithm, Neural networks, Artificial Intelligence, Hidden markov model - application in bioinformatics

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1.David W. Mount, ***"Bioinformatics: Sequence and Genome Analysis"****, Cold Spring Harbor Laboratory Press, Second Edition, 2004.*

2.Arthur M. Lesk, ***"Introduction to Bioinformatics",****Oxford University Press, 2008.*

3.Pierre Baldi, Soren Brunak , ***"Bioinformatics: The machine learning approach"*** *MIT Press, 2001*

REFERENCE BOOKS

1.*Andrew R. Leach, "**Molecular Modeling Principles And Applications",** Second Edition, Prentice Hall, 2001.*

*2.Baxevanis A.D. and Oullette, B.F.F, **"A Practical Guide to the Analysis of Genes and Proteins",** 2nd ed., John Wiley, 2002*

*3.David L. Nelson ,Michael M. Cox , **"Lehninger Principles of Biochemistry"**, Sixth edition, Freeman, W.* H. & Co. Publisher,2012.

COURSE OUTCOMES

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

***CO1**:Understand basic structure of Biological macromolecules*

***CO2:**Acquire the knowledge of biological databases*

***CO3**:Ability to perform pair wise and multiple sequence alignment*

***CO4**:Ability to predict the secondary and tertiary structure of proteins.*

***CO5**:Understand the machine learning approaches in computational biology*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L		L			M				M		
CO2	M	L	L	L					L			L	L		
CO3	L		L			M			L			L		M	
CO4	M	M	L	M	M								L	L	
CO5		M		H	H	M	L		M				L	M	
16BOEX23	L	L	L	L	L	L	L		L			L	L	L	

L-Low, M-Moderate(Medium), H-High

16BOEX24 **BIOLOGY FOR ENGINEERS** **CATEGORY:OE**

(Common to all Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

To enable the students

- *To understand the basic functions of the cell and their mechanisms in transport process*
- *To get familiarize human anatomy and physiology*
- *To learn about microbes, immune system and biomolecules*
- *To know the concepts of applied biology*

UNIT -I BASICS OF CELL BIOLOGY (9)

An Overview of cells – Origin and evolution of cells. Cell theory, Classification of cells – prokaryotic cells and eukaryotic cells. Structure of prokaryotic and eukaryotic cells and their organelles. Comparison of prokaryotic and eukaryotic cells, Transport across membranes – diffusion - active and passive diffusion.

UNIT -II BASICS OF MICROBIOLOGY (9)

Classification of microorganism, Microscopic examination of microorganisms, Structural organization and multiplication of bacteria, viruses, algae and fungi, Microorganism used for the production of penicillin, alcohol and vitamin B -12.

UNIT- III HUMAN ANATOMY AND PHYSIOLOGY (9)

Basics of human anatomy, tissues of the human body: epithelial, connective, nervous and muscular, Nervous system, Respiratory System, Circulatory system and Digestive system.

UNIT- IV BIO MOLECULES AND IMMUNE SYSTEM (9)

Introduction to Biochemistry, Classification, structure and properties of carbohydrates, proteins, lipids and nucleic acids. Innate and acquired immunity, Types of immune responses.

UNIT -V APPLIED BIOLOGY FOR ENGINEERS (9)

Overview of biosensors- glucometer applications-medicine, Microarray analysis to diagnose the cancer, Microbial production of biofuels, Applications of stem cells.

Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS

1.Darnell J, Lodish H, Baltimore D, ***"Molecular Cell Biology",*** *W.H.Freeman; 8th edition,2016*

2.Pelczar MJ, Chan ECS and KreinNR, ***"Microbiology"****, Tata McGraw Hill, 5th edition, New Delhi.2001.*

3.WulfCruger and AnnelieseCruger, ***"A Textbook of Industrial Microbiology"****, Panima Publishing Corporation, 2nd Edition, 2000.*

REFERENCE BOOKS

1.David L. Nelson and Michael M Cox, ***"Lehninger's Principles of Biochemistry"****, Macmillan Worth Publisher, 4th edition, 2004.*

2.Brain R.Eggins , ***"Chemical Sensors and Biosensors"****, John Wiley & Sons, 2002*

3.Anton Moser, ***"Bioprocess Technology, Kinetics and Reactors"*** *Springer, Berlin (Verlag),1998*

4.Kuby J, ***"Immunology"****, WH Freeman & Co., 2000.*

COURSE OUTCOMES

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

CO1:*Understand the functions of cell and their structural organization*

CO2*:Describe the mechanisms and role of cell in immune system*

CO3*:Get familiarized biomolecules and human anatomy system*

CO4*:Illustrate the applications of microbes in industrial process*

CO5*:Apply the engineering concepts in biology*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	L		L	M		L		L	M	L	L	L	
CO2	L		L	L	L	M	M		L	L	L	L	L	L	
CO3	L	L			L	L	L	L	L		L	L	L	L	
CO4	L		L		L			L		L	L	L	L	M	
CO5															
16BOEX24	L	L	L	L	L	L	L	L	L	L	L	L	L	L	

L-Low, M-Moderate(Medium), H-High

16BOEX25 FUNDAMENTALS OF BIOENGINEERING CATEGORY:OE

(Common to all Branches)

L	T	P	C
3	0	0	3

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To make the students aware of the overall industrial bioprocess.*
- *To understand the basic configuration and parts of a fermentor.*
- *To study the production of primary and secondary metabolites.*
- *To understand the production of modern biotechnology products.*

UNIT - I INTRODUCTION TO INDUSTRIAL BIOPROCESS (9)

Fermentation - Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology - A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess.

UNIT - II FERMENTATION INDUSTRY (9)

Overview of fermentation industry, Basic configuration of Fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes. Types of fermentation – Solid state, submerged, batch, continuous, fed batch fermentation methods.

UNIT - III PRODUCTION OF PRIMARY METABOLITES (9)

A brief outline of processes for the production of some commercially important organic acids - Citric acid, lactic acid ,acetic acid; amino acids - glutamic acid, phenylalanine; ethanol.

UNIT - IV PRODUCTION OF SECONDARY METABOLITES (9)

Study of production processes for various classes of secondary metabolites: Antibiotics: beta lactams – penicillin and cephalosporin; aminoglycosides – streptomycin; macrolides - erythromycin, vitamin - B9, B12

UNIT - V PRODUCTS THROUGH MODERN BIOTECHNIQUES (9)

Production of industrial enzymes - proteases, amylases, lipases; Production of single cell protein from wastes; biopreservatives – Bacterosin; biopolymers - xanthan gum and PHA. Industrial uses of enzymes in detergents, beverage and food.

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1.*Peter F. Stanbury, Stephen J. Hall & A. Whitaker,* ***"Principles of Fermentation Technology"****, Science & Technology Books, 1995.*

2.Presscott, S.C. and Cecil G. Dunn, ***"Industrial Microbiology"****, Agrobios (India), 2005.*

3.Casida, L.E. ***"Industrial Microbiology"****, New Age International (P) Ltd, 1968.*

REFERENCE BOOKS

1.*Crueger, W and Anneliese Crueger, Biotechnology:* ***"A Textbook of Industrial Microbiology"****, Panima Publishing Corporation, Edition 2, 2003*

2.Sathyanarayana, U., ***"Biotechnology"****, Books and Allied (P) Ltd. Kolkata, 2005*

3.Ratledge C and Kristiansen B. ***"Basic Biotechnology"****, Cambridge University Press, second Edition, 2001.*

4.Michael J. Waites. ***"Industrial Microbiology: An Introduction",*** *Blackwell Publishing*,2001.

COURSE OUTCOMES

CO1:*Upon completion of the course in Bioprocess Principles graduates will be able to understand the basics of industrial bioprocess.*

CO2*:Explain the principle of a fermentation process and the chronological development of fermentation industry.*

CO3:*Understand the basic configuration of a fermentor and its ancillaries.*

CO4*:Learn the production of various primary and secondary metabolites.*

CO5*:Understand the production of biotechnological products.*

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	H										M		
CO2	H	M													
CO3	H	H	H	M	M	M		L	H					H	
CO4	H	L	L			L		L						H	
CO5	H	M	H	L	M			L						H	
16BOEX25	H	M	M	L	L	L		L	L				L	M	

L-Low, M-Moderate(Medium), H-High

16MOC1Z1 **HUMAN VALUES-I** **CATEGORY:OC**

(Common to all branches)

PRE-REQUISITES : *Nil*

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- *Essential complementarily between 'values' and 'skills' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.*
- *The development of a Holistic perspective among students towards life, profession and happiness based on a correct understanding of the Human reality and the rest of existence, which forms the basis of Value based living in a natural way.*
- *The plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually satisfying human behaviour and mutually enriching interaction with nature.*

UNIT –I INTRODUCTION TO VALUE EDUCATION (5)

Introduction - Need, Basic Guidance, Content and Process for Value Education - Basic human Aspirations – Prosperity and happiness – Methods to fullfill human aspirations - Understanding and living in harmony at various levels.

UNIT –II HARMONY IN THE HUMAN BEING (5)

Coexistence – Happiness and convenience – Appraisal of Physical needs – Mental and Physical health – Human relationship – Mutual Trust and Respect.

UNIT -III ETHICS (5)

Morals, Values and Ethics - Integrity - Work Ethics - Service Learning - Civic Virtue – Caring – Sharing - honesty- Courage – Empathy – Self Confidence -Ethical Human Conduct- Basis for humanistic Education, Constitution and universal order – Competence in professional ethics – Strategy for transition from the present state to Universal human order.

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

TEXT BOOKS

1. *R.R. Gaur, R. Singal,G.P. Bangaria,* ***"Foundation Course in Human Values and Professional Ethics",*** *Excel Book Private Ltd., New Delhi, 2009.*

REFERENCE BOOKS

1. *S. K. Chakraborty and Dabangshu Chakraborty,* ***"Human Values and Ethics: Achieving Holistic Excellence",*** *ICFAI University Press, 2006.*

2. *A.N. Tripathy,* ***"Human Values",*** *New Age International publishers, 2003.*

3. M. Govindarajan, S. Natarajan and V.S. Senthil kumar, ***"Engineering Ethics(including human values)",*** *Eastern Economy Edition, Printice Hall of India Ltd., 2004.*

4. E.G. Seebauer and Rober. L. Berry, ***"Fundamentals of Ethics for Scientists and Engineers",*** *Oxford University Press, 2000.*

COURSE OUTCOMES:

Upon completion of this course the students will be able to

CO1: *Start exploring themselves, get comfortable to each other and to the teacher and start finding the need and relevance for the course.*

CO2: *See that their practice in living is not in harmony with their natural acceptance most of the time and able to refer to their natural acceptance to remove this disharmony.*

CO3: *Aware of their activities like understanding, desire,thought and selection and start finding their focus of attention at different moments.*

CO4: *Able to see that respect is right evaluation and only right evaluation leads to fulfillment in relationship.*

CO5: *Develop an understanding of the whole existence and interconnectedness in nature.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1			M			H	H	H	L				L		
CO2			M			H	H	H	L				L		
CO3			M			H	H	H	L				M		
CO4			M			H	H	H	L					L	
CO5			M			H	H	H	L					L	
16MOC1Z1			M			H	H	H	L				L	L	

L-Low, M-Moderate(Medium), H-High

16MOCX02 HUMAN VALUES AND PROFESSIONAL ETHICS CATEGORY:OC

(Common to all branches)

PRE-REQUISITES : *Nil*

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- Engineering Ethics and Human Values
- Social responsibility of an Engineer
- Ethical dilemma while discharging duties in Professional life.

UNIT -I ENGINEERING ETHICS (5)

Senses of Engineering Ethics - variety of moral issues – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's Theory – Gilligen's Theory – Consensus and contraversy – Models of Professional roles – theories about right actions – Self interest – customs and religion – uses of ethical theories – Valuing time-cooperation-commitment.

UNIT –II ENGINEERING AS SOCIAL EXPERIMENTATION (5)

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

UNIT -III SAFETY, RESPONSIBLITIES, RIGHTS AND GLOBAL ISSUES (5)

Safety and risk – assessment of safety and risk – risk benefit analysis and reducing risk – the three mile island and chernobyl case studies – Environmental ethics – computer ethics – weapons development- Multinational corporations - engineers as expert witnesses and advisors.

Lecture: 15 Periods Tutorial:0 Periods Practical:0 Periods Total: 15 Periods

TEXT BOOKS

1. *Mike Martin and Roland Schinzinger,* ***"Ethics in Engineering",*** *McGraw Hill, New York,1996.*
2. *M. Govindarajan,S. Natarajan and V.S. Senthil kumar,* ***"Engineering Ethics (including human values)",*** *Eastern Economy Edition, Printice Hall of India Ltd., 2004.*

REFERENCE BOOKS

1. *Charles D.Fleddermann,* ***"Engineering Ethics",*** *Pearson Education, 2004.*
2. *Edmund G Seebauer and Robert L. Berry,* ***"Fundamentals of Ethics for Scientists and Engineers****, Oxford University Press,2001.*
3. *Charles E. Harris, Michael S. Protchard and Michael J. Rabins,* ***"Engineering Ethics – Concepts and Cases",*** *Thomson Learning, 2000.*
4. *John R. Boatright,* ***"Ethics and Conduct of Business",*** *Pearson Education,2003.*

COURSE OUTCOMES:

Upon completion of this course the students will be able to

CO1: *Understand and appreciate Human values, exhibit self confidence and develop good Character*

CO2: *Sense engineering ethics, professional roles and valuing time, co-operation and commitment*

CO3: *Uunderstand and practise code of ethics.*

CO4: *Assess safty and risk and capabile of doing risk benefit analysis.*

CO5: *Develop and exhibit moral leadership qualities in exercising Engineering Consultations without compromising envionmental, legal and ethical issues*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1			M			H	H	H	L						H
CO2			M			H	H	H	L				L		
CO3			M			H	H	H	L						M
CO4			M			H	H	H	L					L	
CO5			M			H	H	H	L						H
16MOCX02			M			H	H	H	L				L	L	M

L-Low, M-Moderate(Medium), H-High

16MOCX03 **YOGA FOR YOUTH EMPOWERMENT** **CATEGORY: OC**

(Common to Production Engineering)

L	T	P	C
1	0	0	1

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To create awareness and the benefits of yoga and meditation*
- *To study and analyze the influential factors, which affect the engineering students' healthy life*

UNIT -I PHYSICAL STRUCTURE AND ITS FUNCTIONS (5)

Yoga - Purpose of life, philosophy of life, Physical structure, Importance of physical exercise, Rules and regulation of simplified physical exercises, hand exercise, leg exercise, breathing exercise, eye exercise, kapalapathy, maharasana, body massage, acupressure, body relaxation

UNIT -II YOGASANAS (5)

Rules & Regulations – asana, pranayama, mudra, bandha

UNIT- III MIND (5)

Bio magnetism& mind - imprinting & magnifying – eight essential factors of living beings, Mental frequency and ten stages of mind, benefits of meditation, such as perspicacity, magnanimity, receptivity, adaptability, creativity, Simplified Kundalini yoga: Agna, Santhi, thuriam, thuriyatheetham.

Lecture: 15 Periods Tutorial:0 Periods Practical:0 Periods Total: 15 Periods

TEXT BOOKS

1. *Yoga for Modern Age – Vethathiri Maharashi*
2. *Mind – Vethathiri Maharashi*

COURSE OUTCOMES:

Upon completion of the course, student will be able to

CO 1: YOGA which gives healthy & better living, Physical, Mental mood, Intellectual & spiritual.

CO 2: Work skillfully and perfectly towards the excellence.

CO 3: achieve meditation practices, which strengthen the mind and increases the will power,

CO 4: Concentration, creativity and ultimately to transform the mind to achieve self-realization

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1						H							L		
CO2									M					L	
CO3							L				L		L		L
16MOCX03						L	L		L		L		L	L	L

L-Low, M-Moderate(Medium), H-High

16MOCX04 **BASICS OF CIVIL ENGINEERING** **CATEGORY:OC**

(Common to Production Engineering)

L	T	P	C
1	0	0	1

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

* *To make the students aware of basic concepts of Civil Engineering by exposing the students about the building materials and construction methods followed.*

UNIT -I : BUILDING MATERIALS **(7)**

Qualities of good building stone - Qualities of good brick - Cement composition, types and uses - Properties and uses of tor steel, structural steel sections, timber - Concrete - Grade of concrete - Properties of reinforced concrete.

UNIT -II: BUILDING CONSTRUCTION **(8)**

Foundation functions – Failures - Bearing capacity of soil - Different types of foundation. Masonry - Points to be observed in construction - Brick masonry – Types of bond - Stone masonry - Random rubble and Ashlar masonry. Flooring - Various types of floor finishing for Residential, Industrial buildings.

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *Punmia B.C., "**Basic Civil Engineering**", Lakshmi Publications, 2003.*
2. *Bhavikatti S. S.," **Basic Civil Engineering**", New Age International Publishers, 2010.*

REFERENCE BOOKS

1. *Rangwala S .C., "**Engineering Materials**", Charotar Publishing House, 2014.*
2. *Punmia B. C., "**Building Construction**", Lakshmi Publications, 2008.*

COURSE OUTCOMES

On completion of this course, students will be able to

CO1: Know the qualities and properties for building materials used in the field

CO2: Apply the knowledge of construction practices in real life situation in the societal context.

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L		L						L					
CO2						L		L	M	M	H	L			
16MOCX04	M	L		L		L		L	L	M	M	L			

L-Low, M-Moderate(Medium), H-High

16MOCX05 **METALLOGRAPHY** **CATEGORY:OC**

L	T	P	C
1	0	0	1

PRE-REQUISITES:

16MPC305 Engineering Metallurgy

COURSE OBJECTIVE:

- *To understand the preparation of metallographic specimens for micro examination and analyze the microstructures of metals and metallic alloys.*

UNIT- I PREPARATION OF METALLOGRAPHIC SPECIMENS (5)

Microscopic and macroscopic examination, Polishing techniques for different metals and alloys, Sectioning- Fracturing, Shearing, Sawing, Abrasive cutting, Electric discharge machining, Mounting-Adhesive mounting, Plastic mounting, Grinding and Etching techniques - Electrolytic etching, Potentiostat etching, Chemical etching.

UNIT -II MICROSTRUCTURES OF FERROUS AND NON FERROUS METALS (5)

Crystalline structure of metals, Phase changes of metals and alloys, Crystal defects in metals, Microstructures of plain carbon steel, tool steel, grey C.I, SG iron, Brass, Bronze and composites.

UNIT -III IMAGE ANALYSING TECHNIQUES (5)

Light microscopy, SEM, TEM, XRD, Quantitative microscopy-Grain size measurement, Inclusion rating methods, Measurements of structural gradients - Decarburization, Case depth, Coating thickness, Quantitative fractography, Image analysis.

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

REFERENCE BOOKS

1. *O.P. Khanna **"Material Science & Metallurgy",** Dhanpat Rai Publication ,2011*
2. *Sydney H. Avner **"Introduction to Physical Metallurgy",**Tata McGraw Hill Book Company, 1994.*
3. *R.C. Gifkins, **"Optical Microscopy of Metals",** American Elsevier Pub. Co., 1970*
4. *S.Telansky, **"Multiple beam interference Microscopy of Metals",** Academic Press, New York, 1970.*
5. *Kay Geels, **"Metallographic and Materialographic Specimen Preparation, Light Microscopy, Image Analysis and Hardness Testing",** ASTM International, U.S.A. ASTM Stock No. MNL46.*

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: Apply the specimen preparation methods in metallographic inspection.

CO2: Identify the phase changes of microstructures and defects in metals and metallic alloys.

CO3:Analyze the microstructures and defects in metals and metallic alloys.

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M												L		
CO2	H	H			H	M				M			H	M	
CO3	H	H			H	M				M			H	M	
16MOCX05	H	H			H	L				L			M	L	

L-Low, M-Moderate(Medium), H-High

16MOCX06 **DESIGN OF EXPERIMENTS USING TAGUCHI TECHNIQUES** **CATEGORY:OC**

L	T	P	C
1	0	0	1

PRE-REQUISITES:

16MBS1Z2 Engineering Mathematics I

COURSE OBJECTIVES:

- To expose to designed experiments, importance and experimentation using scientific approach

UNIT -I EXPERIMENTAL DESIGN FUNDAMENTALS (3)

Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps in experimentation.

UNIT -II TAGUCHI PHILOSOPHY ORTHOGONAL ARRAY EXPERIMENTS (8)

Taguchi philosophy and methodology – Loss Function – Quality engineering – Quality by design controllable and noise - Structure and use of two-level orthogonal arrays – three level orthogonal arrays – linear graphs – Steps in experimentation, design using Orthogonal Arrays.

UNIT -III DATA ANALYSIS AND OPTIMIZATION (4)

Robust design- control and noise factors, S/N ratios, parameter design, Single-response optimization

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

REFERENCE BOOKS:

1. Phillip J.Rose, "**Taguchi techniques for quality engineering**", McGraw Hill Professional, 1996.
2. Montgomery, D.C., " **Design and Analysis of experiments"**, John Wiley and Sons, Eighth edition, 2012.
3. *Krishnaiah, K. and Shahabudeen, P. "***Applied Design of Experiments and Taguchi Methods"***, PHI learning private Ltd., 2012*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1: Select and prepare a experimental design methodology and conduct experiments

CO 2: Apply experimentation using Orthogonal Arrays to meet the societal needs with respect to standard of life.

CO 3: Interpret and implement the results of the experiments using Taguchi technique, and optimize an existing system to reduce cost.

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	L	H									L	L	
CO2	H													M	
CO3			M	H										M	
16MOCX06	M	L	L	M									L	M	

L-Low, M-Moderate(Medium), H-High

16MOCX07 **MICROMACHINING** **CATEGORY:OC**

L	T	P	C
1	0	0	1

PRE-REQUISITES:
16MPC406 Manufacturing Technology II

COURSE OBJECTIVE:

- To be familiar with the principles, basic machine tools, and developments in the micro machining processes.

UNIT - I INTRODUCTION TO MICROMACHINING (05)
Introduction to Micromachining- Traditional Micromachining Processes - Diamond Turning – Micromilling – Microgrinding - Metrology for micro machined components - Applications.

UNIT - II ADVANCED MICROMACHINING AND NANOFINISHING PROCESSES (05)
Water Jet Micro Machining - Abrasive Jet Micromachining - Ultrasonic Micromachining - Electrochemical Micromachining - Electrochemical Micro Grinding - Electrostream Microdrilling - Electrochemical Microdeburring - Shaped Tube Electrolytic Micromachining- Chemical Micromachining (ChMM).

UNIT - III NANO POLISHING (05)
Abrasive Flow Nanofinishing - Magnetic Abrasive Nanofinishing- Magneto rheological finishing – Magneto Rheological abrasive flow finishing - Magnetic Float polishing – Elastic Emission Machining – chemo-mechanical Polishing.

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

REFERENCE BOOKS:

1. *M.J.Jackson,* **"Microfabrication and Nanomanufacturing",** *Taylor & Francis, CRC Press,2005.*
2. *Jain V. K.,"* **Micro Manufacturing Processes"** *CRC Press, Taylor & Francis Group, 2012.*
3. *Mcgeough. J.A., "**Micromachining of Engineering Materials"**, CRC press 2001.*
4. *http://www.cmxr.com/Education/Introduction.html*

COURSE OUTCOMES:

At the end of the course students will be able to

CO 1 : *Apply various traditional micro machining processes in industrial needs.*

CO 2 : *Identify various mechanical and electrical energy based micro machining processes in engineering applications.*

CO 3 : *Apply the* knowledge *of nano polishing techniques in engineering applications.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M										M		
CO2	M	M	M										M		
CO3	H	M	M										M		
16MOCX07	M	M	M										M		

L-Low, M-Moderate(Medium), H-High

16MOCX08 **WIND ENERGY MANAGEMENT** **CATEGORY:OC**

L	T	P	C
1	0	0	1

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To study the concept of wind energy generation*
- *To understand the fundamentals of wind energy and its conversion system*
- *To learn wind turbine control & monitoring*

UNIT - I WIND ENERGY (5)

Nature of the wind - power in the wind - factors influencing wind - wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy – Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept.

UNIT - II AERODYNAMICS THEORY & WIND TURBINE TYPES (5)

Airfoil terminology, Blade element theory, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type.

UNIT - III MODERN WIND TURBINE CONTROL & MONITORING SYSTEM (5)

Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA & Databases: Remote Monitoring and Generation Reports, Operation & Maintenance for Product Life Cycle, Balancing technique (Rotor & Blade), FACTS control & LVRT & New trends for new Grid Codes.

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

REFERENCE BOOKS:

1. *Freris, L.L., **"Wind Energy Conversion Systems"**, Prentice Hall, 1990.*
2. *Mario Garcia –Sanz, Constantine H. Houpis, **"Wind Energy Systems"**, CRC Press 2012.*
3. *Spera, D.A., **"Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering"**, ASME Press, 1994.*
4. *Twidell, J.W. and Weir, A., **"Renewable Energy Sources"**, EFN Spon Ltd., 1983.*
5. *John D Sorensen and Jens N Sorensen, **"Wind Energy Systems"**, Woodhead Publishing Ltd, 2011.*

COURSE OUTCOME:

On completion of this course, students will be able to

CO 1: *Knowledge in conversion techniques of wind energy*

CO 2: *Learning of wind turbine components and their construction*

CO 3: *Understating of wind turbine control & monitoring*

CO 4: *Knowledge in working principle of Wind energy system*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	H	L	M				M				L		L	M	
CO 2	L		H									L	L	M	
CO 3					H	L					M			L	
CO 4	M		M								H		M		M
16MOCX08	M	L	M		L	L	L				M	L	L	L	L

L-Low, M-Moderate(Medium), H-High

16MOCX09 **SOLAR ENERGY MANAGEMENT** **CATEGORY:OC**

L	T	P	C
1	0	0	1

PRE-REQUISITES:

16MPEX03 Power Plant Engineering

COURSE OBJECTIVE:

- *To understand and appreciate the solar energy crisis and environmental concerns associated with the energy management, and the importance of solar energy conservation in society and legal acts*.

UNIT - I SOLAR RADIATION AND AVAILABILITY (5)

Source of radiation – solar constant– solar charts – Measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder

UNIT - II SOLAR ENERGY COLLECTORS (5)

Solar Non-Concentrating Collectors – Design considerations – Classification air, liquid heating collectors –Derivation of efficiency and testing of flat plate collectors –Analysis of concentric tube collector – Solar green house.

UNIT - III ENERGY MANAGEMENT (5)

Supply side and demand side management – Energy conservation methods – Energy management systems – Energy monitoring – Energy review and energy bench marking – Energy action planning – Energy auditing. Energy policy – Energy conservation act 2001 – Energy labeling and energy standards.

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

REFERENCE BOOKS:

1. *D. Yogi Goswami, Frank Kreith, Jan. F. Kreider,* ***"Principles of Solar Engineering"****, 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003*
2. *Sukhatme SP,* ***"Solar Energy: Principles of Thermal collection and Storage"****, Tata McGraw-Hill, 1996.*
3. *W. Shepherd and D. W. Shepherd, "****Energy Studies",*** *Second Edition Imperial College Press, London, 2004*

COURSE OUTCOMES

CO1: Gaining awareness on working, construction and performance evaluation of solar photovoltaic and solar thermal devices

CO2: Describe the challenges and problems associated with the use of solar energy and its impacts on environment

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	L	H	M	M	M	L	L	M	H	H	M	M	L	H	H
CO 2	M	M	H	M	L	M	M	L	H	M	M	L	H	M	H
16MOCX09	M	H	H	M	M	M	M	M	H	H	M	M	M	H	H

L-Low, M-Moderate(Medium), H-High

16MOCX10 **PROJECT MANAGEMENT** **CATEGORY:OC**

L	T	P	C
1	0	0	1

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To prepare the students to identify, plan, develop, manage, successfully implement, execute and finish the projects within stipulated time in their chosen area.*

UNIT - I BASICS OF PROJECT MANAGEMENT (5)

Introduction, definition of project and project management, project objectives, classification of projects, need for project management, project management knowledge areas and processes, project life cycle, project management principles.

UNIT - II PROJECT IDENTIFICATION AND PLANNING (5)

Project identification process - project initiation, pre-feasibility study, feasibility studies, project break-even point, Project planning -need of project planning, project life cycle, roles, responsibility and team work, project planning process.

UNIT - III PROJECT IMPLEMENTATION AND EXECUTION (5)

Organizational structure influences on projects, project risk management- role of risk management in overall project management, steps in risk management, project execution -project control process and case studies in project management.

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

REFERENCE BOOKS:

1. *Clifford F. Gray, Erik W. Larson., **"Project Management: The Managerial Process"**, McGraw Hill, 6th Edition, 2014.*
2. *Gary R.Heerkens.," **Project Management"** McGraw Hill, 2002.*
3. *Nick Jenkins., "**A Project Management Primer"**, 2006.*
4. *Robert K. Wysocki "**Effective Project Management"** Wiley Publishers, 2013.*
5. *Jack R. Meredith and Samuel J. Mantel., "**Project Management, A Managerial Approach**"John Wiley & Sons, 2015.*

COURSE OUTCOMES

On completion of this course, students will be able to

CO1: Apply the concepts of project management in engineering.

CO2: Identify and plan new projects.

CO3: Implement and execute new projects.

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	L				L	L		L	H	M	L	H	L	L	L
CO 2	L				L	L		L	H	M	L	H	L	L	L
CO 3	L				L	L		L	H	M	L	H	L	L	L
16MOCX10	L				L	L		L	H	M	L	H	L	L	L

L-Low, M-Moderate(Medium), H-High

16MOCX11 PERSONALITY DEVELOPMENT CATEGORY:OC

L	T	P	C
1	0	0	1

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To provide learners with the capacity of analyzing strength and weakness, Group dynamics, team building and interpersonal skills*

UNIT - I PERSONALITY (5)

Basics of personality, analyzing strength and weaknesses, Theories on personality development, increasing vocabulary, body language and communication skills. Building self – esteem and self-confidence.

UNIT - II STRESS MANAGEMENT, CONFLICT AND TIME MANAGEMENT (5)

Analysis of ego states, transactions, causes of stress management, impact and managing stress. Conflict management: Levels of conflict and managing conflict. Time management: importance and need, steps towards better time management.

UNIT - III POSITIVE SOCIAL IMAGE (5)

Importance of social image, public speaking, voice modulation, social graces and proper email and telephone etiquette. Social etiquette and table manners. .

Lecture: 15 Periods Tutorial:0 Periods Practical:0 Periods Total: 15 Periods

REFERENCE BOOKS:

1. Samuelraj,"***Personality Development"***, Laxmi Publications*, 2015.*
2. Bahaudin Ghulam Mujtaba & Timothy McCartney , "**Managing Workplace Stress and Conflict amid Change"**, Aeon *Publishing* Inc , Second edition , 2009
3. P. Alex Linely and Stephen, "**Positive Psychology in Practice"**, John Wiley & sons Inc., New Jersey, 2012

COURSE OUTCOMES:

On completion of this course the student will be able to

CO1: A*ppreciate personality development and self-confidence*.

CO2: *Understand and manage the impact of stress.*

CO3: *Develop and exhibit good social image and etiquettes*.

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1					L	M		M	M	M	L		L		L
CO 2					L	M		M	M	M	L		L		L
CO 3					L	M		M	M	M	L		L		L
16MOCX11					L	M		M	M	M	L		L		L

L-Low, M-Moderate(Medium), H-High

16MOCX12 **SIX SIGMA** **CATEGORY:OC**

(Common to Production Engineering)

L	T	P	C
1	0	0	1

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- To impart knowledge on six sigma tools on projects and successful completion of projects that drive meaningful business results.

UNIT - I SIX SIGMA, QUALITY AND STANDARDS (5)

Meaning and use of the Six Sigma approach- the underlying concept of variation- the relationships to related Quality Management approaches – Basic six sigma tools – Nature of six sigma improvements projects.

UNIT - II DEFINING THE PROJECT MISSION (5)

Focus on creativity and creativity tools used in coming up with creative formulations and solutions in Six Sigma improvement projects.-Review and management of Six Sigma projects

UNIT - III INTRODUCTION TO STATISTICS AND EXCEL (5)

Statistical techniques for summarizing data and extensive use of Microsoft Excel-Statistical Process control.

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

REFERENCE BOOKS

1. *Joseph A De Feo, William W Bearnard Juran Institute" **Six Sigma Break Through and Beyond**", Tata McGraw Hill, New Delhi, 2004.*
2. *Richard B Chase F Robert Jacobs and Nicholas J Aquilano, "**Operations Management for Competitive Advantage**", McGraw Hill Inc., New York, Tenth Edition, 2003.*
3. *Poka - Yoke, "**Improving Product Quality by Preventing Defects**", Productivity Press, Portland, Oregon, 1993.*
4. *George Eckes **"Six Sigma for Everyone",** John Wiley & Sons", 2003.*
5. *J M Juran , F.M.Gyna&R.S.Bingham **, "Quality control Hand book" ,** McGraw Hill book co,1979.*

COURSE OUTCOMES:

At the end of the course students will be able to

CO1*: Implement six sigma in real world applications for quality standard*

CO2*: Analyze six sigma tools in organizational projects.*

CO3*: Apply the statistical techniques in engineering applications.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	H	M	M	L	L	M	L	L	L	L	L	H	H	M	L
CO 2	H	H	L	L	M	M	L	L	M	M	L	H	H	M	L
CO 3	H	L		H	H	M	L		M		L	M	H	M	L
16MOCX12	H	M	L	M	M	M	L	L	M	L	L	H	H	M	L

L-Low, M-Moderate(Medium), H-High

16MOCX13 **BIO FUELS TECHNOLOGY** **CATEGORY:OC**

L	T	P	C
1	0	0	1

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To acquire adequate knowledge about bio fuel, its energy and technology.*

UNIT - I INTRODUCTION (5)

Energy and Environment Overview – Energy scenario in India – Importance of biodiesel in India - Sources of Biodiesel - Biodiesel standards - Emission standards.

UNIT - II VEGETABLE OILS (5)

Availability of vegetable oils -Non-edible oils as biodiesel - Scenario of non-edible oils in India - Blending, Emulsification, Pre heating – transesterification.

UNIT - III PERFORMANCE, COMBUSTION AND EMISSIONS CHARACTERISTICS OF BIODIESEL FUEL (5)

Performance parameters of Biodiesel and blends - Combustion characteristics of Biodiesel -ignition delay, maximum pressure, combustion duration, maximum temperature, heat release rate and mass burning rate - Emission characteristics of Biodiesel and blends.

Lecture: 15 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**

REFERENCE BOOKS:

1. *Richard L Bechtold, "**Automotive Fuels Guide Book"** SAE Publications, 2014.*
2. *Tickell, Joshua, Tickell, Kaia, "**From the Fryer to the Fuel Tank, The Complete Guide to using vegetable oils as an alternative Fuel**", Second Edition 1999.*
3. *Sheehan, J., Camobreco, V., Duffield, J., Grabuski .M, & Shapouri, H, **"Life Cycle inventory of Biodiesel and Petroleum Diesel for use in an urban Bus**", Report Number NREL /SR-580-24089, National Renewable Energy Laboratory.*
4. *Biodiesel Handling and use Guidelines (2004). "**Energy Efficiency and Renewable Energy"**, U.S. Department of Energy.*
5. *ASM Handbook on "**Lubrication and Lubricants**"*

COURSE OUTCOMES

On completion of the course students will be able to

***CO 1:** Apply bio fuel standards and emission norms*

***CO2:** Identify the behavior of vegetable oil*

***CO3**: Analyze the combustion phenomena of bio fuels*.

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	M	L	L			H	L				L		L		L
CO 2	M	L	L	L		H	L				L		L	L	L
CO 3	M	L	L	L		H	L				L		L	H	L
16MOCX13	M	L	L	L		H	L				L		L	L	L

L-Low, M-Moderate(Medium), H-High

16MOCX14 **PROFESSIONAL SKILLS** **CATEGORY:OC**

L	T	P	C
1	0	0	1

PRE-REQUISITES : *Nil*

COURSE OBJECTIVES:

- *To inculcate administrative skills in students minds to make them able to administrate effectively for project implementation.*

UNIT – I SELF ANALYSIS AND CREATIVITY (5)

SWOT Analysis, Who am I, Attributes, Importance of Self Confidence, Self Esteem. Out of box thinking, Lateral Thinking.

UNIT – II LEADERSHIP (5)

Skills for a good Leader, Assessment of Leadership Skills, Conflicts in Human Relations – Reasons Case Studies, Approaches to conflict resolution.

UNIT – III DECISION MAKING (5)

Importance and necessity of Decision Making, Process and practical way of Decision Making, Weighing Positives & Negatives.

Lecture: 15 Periods Tutorial:0 Periods Practical:0 Periods Total: 15 Periods

REFERENCE BOOKS:

1. *Covey Sean, "**Seven Habits of Highly Effective Teens**", New York, Fireside Publishers, 1998.*
2. *Carnegie Dale, "**How to win Friends and Influence People",** New York: Simon & Schuster, 1998.*
3. *Thomas A Harris, **"I am ok, You are ok "**, New York-Harper and Row, 1972*
4. *Daniel Coleman, **"Emotional Intelligence",** Bantam Book, 2006*
5. *Soft Skills, 2015, **"Career Development Centre"**, Green Pearl Publications.*

COURSE OUTCOMES

On completion of this course the student will be able to

- ***CO 1:*** *Do self analysis and process a positive approach.*
- ***CO 2:*** *Develop leadership qualities to solve conflicts and maintain good relationship with personals.*
- ***CO 3:*** *Make decision for effective project implementation.*

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1						L		H	M		L	M	L		H
CO 2								H	M			M	L		H
CO 3				L		L		M	M			M	L		M
16MOCX14				L		L		H	M		L	M	L		H

L-Low, M-Moderate(Medium), H-High