DEPARTMENT OF MECHANICAL ENGINEERING

Course Book for

B. Tech. in Mechanical Engineering

For

Academic Year: 2020 – 2021

Visvesvaraya National Institute of Technology,

Nagpur-440 010 (MH)

Institute Vision Statement

To contribute effectively to the National and International endeavour of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country and the World incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation.

Institute Mission Statement

The mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. VNIT is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

Department Vision Statement

To produce quality human resource of high standard in mechanical engineering who can contribute favorably to the technological and socio-economic development of the nation.

Department Mission Statement

To develop state of the art facilities related to mechanical engineering. To attract highly qualified faculty to the mechanical engineering department. To promote participation of industries in academics, research and consultancy. To undertake research at regional and national level.

Brief about Mechanical Department

Department of Mechanical Engineering is one of the oldest department started in 1960, scurrently department is offering 1 UG and 3 PG programmes. Faculty members of the department are highly motivated for teaching and conducting research in the diversified fields of mechanical engineering.

List of faculty Members

Sr No	Faculty Name	Areas of specialization
1	Dr. P. M. Padole	Design Engineering
2	Dr. H. T. Thorat	Design and Industrial Engineering
3	Dr. S. B. Thombre	Thermal Engineering
4	Dr. A. M. Kuthe	Manufacturing
5	Dr. V. R. Kalamkar	Thermal Engineering
6	Dr. A. Chatterjee	Design Engineering
7	Dr. Y. M. Puri	Manufacturing and Industrial Engineering
8	Dr. D. B. Zodpe	Thermal Engineering
9	Dr. A. B. Andhare	Manufacturing
10	Dr. J. G. Suryawanshi	Thermal Engineering
11	Dr. S. S. Chiddarwar	Manufacturing and Design Engineering
12	Dr. R. V. Uddanwadikar	Design Engineering
13	Dr. A. S. Dhoble	Thermal Engineering
14	Dr. H.P. Jawale	Design Engineering
15	Dr. M. S. Kotambkar	Design Engineering
16	Dr. A. K. Singh	Design and Thermal Engineering
17	Dr. Trushar B Gohil	Thermal Engineering
18	Dr. T. V. K. Gupta	Manufacturing
19	Dr. Ravikumar Dumpala	Manufacturing
20	Dr. R. K. Peetala	Thermal Engineering
21	Dr. P. V. Kane	Industrial Engineering
22	Dr. D. A. Jolhe	Industrial Engineering
23	Dr. V. M. Nistane	Design Engineering
24	Dr. G. Tiwari	Design Engineering
25	Dr. S Roga	Thermal Engineering
26	Dr. A. A. Thakre	Design and Industrial Engineering
27	Dr. K. M. Asthankar	Industrial Engineering
28	Dr. P. D. Sawarkar	Thermal Engineering
29	Dr. N. K. Lautre	Industrial Engineering

UG/ PG Programmes Offered by Mechanical Department:

The department offers following undergraduate and postgraduate programmes

	Program	Description
UG	B. Tech in Mechanical Engineering	Intake: 115
PG	M. Tech. in 1. Computer Aided Design & Manufacturing 2. Industrial Engineering 3. Heat Power Engineering	Intake : 25 each

Credit System at VNIT :

Education at the Institute is organized around the semester-based credit system of study. The prominent features of the credit system are a process of continuous evaluation of a student's performance / progress and flexibility to allow a student to progress at an optimum pace suited to his/her ability or convenience, subject to fulfilling minimum requirements for continuation. A student's performance/progress is measured by the number of credits he/she has earned, i.e. completed satisfactorily. Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum number of credits and a minimum grade point average must be acquired by a student in order to qualify for the degree.

Course credits assignment

Each course, except a few special courses, has certain number of credits assigned to it depending on lecture, tutorial and laboratory contact hours in a week.

For Lectures and Tutorials: One lecture hour per week per semester is assigned one credit and

For Practical/ Laboratory/ Studio: One hour per week per semester is assigned half credit.

Example: Course XXXXXX with (3-0-2) as (L-T-P) structure, i.e. 3 hr Lectures + 0 hr Tutorial + 2 hr Practical per week, will have (3x1 + 0x1 + 2x0.5 =) 4 credits.

Grading System

The grading reflects a student's own proficiency in the course. While relative standing of the student is clearly indicated by his/her grades, the process of awarding grades is based on fitting performance of the class to some statistical distribution. The course coordinator and associated

faculty members for a course formulate appropriate procedure to award grades. These grades are reflective of the student's performance vis-à-vis instructor's expectation. If a student is declared pass in a subject, then he/she gets the credits associated with that subject.

Depending on marks scored in a subject, a student is given a Grade. Each grade has got certain grade points as follows:

Grade	Grade points	Description
AA	10	Outstanding
AB	9	Excellent
BB	8	Very good
BC	7	Good
CC	6	Average
CD	5	Below average
DD	4	Marginal (Pass Grade)
FF	0	Poor (Fail) /Unsatisfactory / Absence from end-sem exam
NP	-	Audit pass
NF	-	Audit fail
SS	-	Satisfactory performance in zero credit core course
ZZ	-	Unsatisfactory performance in zero credit core course
W	-	Insufficient attendance

Performance Evaluation

The performance of a student is evaluated in terms of two indices, viz, the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. CGPA is rounded up to second decimal.

The Earned Credits (ECR) are defined as the sum of course credits for courses in which students have been awarded grades between AA to DD. Grades obtained in the audit courses are not counted for computation of grade point average.

Earned Grade Points in a semester (EGP) = **Σ** (Course credits x Grade point) for courses in which AA- DD grade has been obtained

SGPA = EGP / Σ (Course credits) for courses registered in a semester in which AA- FF grades are awarded

CGPA= EGP / Σ(Course credits) for courses passed in all completed semesters in which AA- DD grades are awarded.

Overall Credits Requirement for Award of Degree

SN	Category of Course	Symbol	Credit Requirement			
			B. Tech. (4-Year)	B. Arch. (5 Year)	M. Tech. (2 Year)	M. Sc. (2 Year)
	Program Core					
1	Basic Sciences (BS)	BS	18	04	-	-
2	Engineering Arts & Sciences (ES)	ES	20	18	-	-
3	Humanities	HU/ HM*	05	06	-	-
4	Departmental core	DC	79-82	168	33-39	54-57
	Program Elective					
3	Departmental Elective	DE	33-48	17-23	13-19	06-09
4	Humanities & Management	HM	0-6	0-3	-	-
5	Open Course	OC	0-6	0-3	-	-
Total requirement :BS + ES + DC+ DE + HM + OC =			**170**	**219**	**52**	**63**
Minimum Cumulative Grade Point Average required for the award of degree			**4.00**	**4.00**	**6.00**	**4.00**

Attendance Rules

1. All students must attend every class and 100% attendance is expected from the students. However, in consideration of the constraints/ unavoidable circumstances, the attendance can be relaxed by course coordinator only to the extent of not more than 25%. Every student must attend minimum of 75% of the classes actually held for that course.
2. A student with less than 75% attendance in a course during the semester, will be awarded W grade. Such a student will not be eligible to appear for the end semester and re-examination of that course. Even if such a student happens to appear for these examinations, then, answer books of such students will not be evaluated.
3. A student with W grade is not eligible to appear for end semester examination, reexamination & summer term.

Program Outcomes for B. Tech in Mechanical Engineering

a. The graduates will be able to apply knowledge of basic sciences (math, physics, chemistry etc.) and engineering (core and elective subjects) in getting solutions to mechanical engineering related problems.
b. The graduates will be able to design and conduct experiments as well as analyze and interpret data.
c. The graduates will be able to design a system or a component of a system for a specific task within realistic constraints.
d. The graduates will be able to undertake multi disciplinary courses and tasks.
e. The graduates will be able to formulate and apply the knowledge of mathematical techniques in solving the governing equations of a system under consideration.
f. The graduates will be able to develop industrial and professional ethics and managerial skills.
g. The graduates will be able to communicate effectively their point of views
h. The graduates will be able to study the impact of mechanical systems on the global, economic, environmental and societal context.
i. The graduates will acquire attitude for life- long learning.
j. The graduate will be able to use modern tools, software, equipment etc. to analyze and obtain solution to the problems.
k. The graduates will be able to participate in competitive examinations for success.

Curriculum of the courses of study

First Year (Semester I & II)

Courses to Register in First Year B.Tech.
(*Sections R, S, T, U, L*)

I Semester				
Code	**Course**	**Type**	**L-T-P**	**Credits**
AML151	Engineering Mechanics	ES	3-1-0	4
AMP151	Engineering Mechanics Laboratory	ES	0-0-2	1
HUL101	Communication Skills	HM	2-0-2	3
MAL101	Mathematics – I	BS	3-1-0	4
MEL101	Engineering Drawing	ES	3-0-0	3
MEP101	Engineering Drawing Practical	ES	0-0-2	1
PHL101	Physics	BS	3-1-0	4
PHP101	Physics Laboratory	BS	0-0-2	1
SAP101	Health Information and Sports –Part I	AU	0-0-2	0
			Total Credits	21
II Semester				
Code	**Course**	**Type**	**L-T-P**	**Credits**
CHL101	Chemistry	BS	3-1-0	4
CHP101	Chemistry Laboratory	BS	0-0-2	1
CSL101	Computer Programming	ES	3-0-2	4
EEL101	Electrical Engineering	ES	3-1-0	4
EEP101	Electrical Engineering Laboratory	ES	0-0-2	1
HUL102	Social Science	HM	2-0-0	2
MAL102	Mathematics – II	BS	3-1-0	4
MEP102	Workshop	ES	0-0-4	2
SAP102	Health Information and Sports –Part II	AU	0-0-2	0
			Total Credits	22

L-T-P = 3-1-0 Means, Three Theory Hrs + One Tutorial hrs + Zero Labs or Practical Hrs per Week. L-T-P = 0-0-2 Means, Two Hrs of Lab or Practical per Week

Courses to Register in First Year B.Tech.
(*Sections W, X, Y, Z, N*)

I Semester				
Code	**Course**	**Type**	**L-T-P**	**Credits**
CHL101	Chemistry	BS	3-1-0	4
CHP101	Chemistry Laboratory	BS	0-0-2	1
CSL101	Computer Programming	ES	3-0-2	4
EEL101	Electrical Engineering	ES	3-1-0	4
EEP101	Electrical Engineering Laboratory	ES	0-0-2	1
HUL102	Social Science	HM	2-0-0	2
MAL101	Mathematics – I	BS	3-1-0	4
MEP102	Workshop	ES	0-0-4	2
SAP102	Health Information and Sports –Part I	AU	0-0-2	0
			Total Credits	22
II Semester				
Code	**Course**	**Type**	**L-T-P**	**Credits**
AML151	Engineering Mechanics	ES	3-1-0	4
AMP151	Engineering Mechanics Laboratory	ES	0-0-2	1
HUL101	Communication Skills	HM	2-0-2	3
MAL102	Mathematics – II	BS	3-1-0	4
MEL101	Engineering Drawing	ES	3-0-0	3
MEP101	Engineering Drawing Practical	ES	0-0-2	1
PHL101	Physics	BS	3-1-0	4
PHP101	Physics Laboratory	BS	0-0-2	1
SAP101	Health Information and Sports –Part II	AU	0-0-2	0
			Total Credits	21

L-T-P = 3-1-0 Means, Three Theory Hrs + One Tutorial hrs + Zero Labs or Practical Hrs per Week.

L-T-P = 0-0-2 Means, Two Hrs of Lab or Practical per Week

Scheme for B. Tech. in Mechanical Engineering, VNIT Nagpur

Semester III

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MEL203	ENGINEERING THERMODYNAMICS	DC	3-1-0	4
2	MEL204	ENGINEERING METALLURGY	DC	3-0-0	3
3	MEP204	ENGINEERING METALLURGY	DC	0-0-2	1
4	MAL201	INTEGRAL TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	DC	3-1-0	4
5	MEL206	SOLID MECHANICS	DC	3-1-0	4
6	MEL201	THEORY OF MACHINE - I	DC	3-1-0	4
	Core Credits = 20				
	DC + DE = 20 Credits				

Semester IV

Sr.No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MEL 202	FLUID MECHANICS	DC	3-1-0	4
2	MEP 202	FLUID MECHANICS	DC	0-0-2	1
3	MEL207	MANUFACTURING PROCESS-I	DC	3-0-0	3
4	MEL304	MACHINE DESIGN-I	DC	3-0-0	3
5	MEL301	THEORY OF MACHINE-II	DC	3-0-0	3
6	MEP301	THEORY OF MACHINE-II	DC	0-0-2	1
7	MEL303	ENERGY CONVERSION-I	DC	4-0-0	4
8	MEP207	MANUFACTURING PROCESS-I	DC	0-0-2	1
9	MEP208	DESIGN LAB-I	DC	0-0-2	1
	Core Credits = 21				
	DC + DE = 21 Credits				

Semester V

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MEL302	HEAT TRANSFER	DC	4-0-0	4
2	MEL308	ENERGY CONVERSION- II	DC	3-0-0	3
3	MEL305	MANUFACTURING PROCESS II	DC	3-0-0	3
4	MEL307	FLUID MACHINES	DC	3-0-0	3
5	MEP307	FLUID MACHINES	DC	0-0-2	1
6	MEP305	MANUFACTURING PROCESS II	DC	0-0-2	1
7	MEL313	MACHINE DRAWING	DC	2-0-0	2
8	MEP313	MACHINE DRAWING	DC	0-0-2	1
9	MEP302	THERMAL	DC	0-0-2	1
	Core Credits = 19				
	Elective (Any one)				
10	MEL416	INDUSTRIAL ROBOTICS	DE	3-0-0	3
11	MEL421	COMPUTATIONAL METHODS IN ENGINEERING	DE	3-0-0	3
12		OC/HM	DE	3-0-0	3
	Elective Credits = 3				
	DC + DE = 22 Credits				

Semester VI

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MEL311	METROLOGY AND QUALITY ASSURANCE	DC	3-0-0	3
2	MEL312	MECHANICAL MEASUREMENTS	DC	3-0-0	3
3	MEP314	MECHANICAL MEASUREMENT AND METROLOGY	DC	0-0-2	1
4	MEL309	MACHINE DESIGN-II	DC	3-1-0	4

5	MEL310	MANUFACTURING PROCESSES AUTOMATION	DC	3-0-0	3
6	MEP310	MANUFACTURING PROCESSES AUTOMATION	DC	0-0-2	1
7	MEP309	MACHINE DESIGN-II	DC	0-0-2	1
	Core Credits = 16				
	Elective (Any one)				
8	MEL432	COMPUTER GRAPHICS AND SOLID MODELING	DE	3-0-0	3
	MEP432	COMPUTER GRAPHICS AND SOLID MODELING	DE	0-0-2	1
9	MEL442	COMPUTER & DATABASE MANAGEMENT	DE	3-0-0	3
	MEP442	COMPUTER & DATABASE MANAGEMENT	DE	0-0-2	1
10	MEL422	AUTOMOBILE ENGINEERING	DE	3-0-0	3
	MEP422	AUTOMOBILE ENGINEERING	DE	0-0-2	1
	Elective (Any one)				
11	MEL429	RENEWABLE ENERGY SOURCES	DE	3-0-0	3
12	MEL415	MECHANICAL VIBRATION	DE	3-0-0	3
13	MEP452	MACHINE SYSTEM DESIGN	DE	0-1-4	3
14	MEL315	INTRODUCTION TO AEROSPACE ENGINEERING	DE	3-0-0	3
15	MEL***	DESIGN OF FIXTURES IN MANUFACTURING	DE	3-0-0	3
16	MEL***	DYNAMICS OF MECHANICAL SYSTEM	DE	3-0-0	3
17		OC/HM	DE	3-0-0	3
	Elective Credits = 7				
	DC + DE = 23 Credits				

Semester VII

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MED401	PROJECT PHASE-I	DC		2
	Core Credits = 2				
	Elective (Any one)				
2	MEL435	COMPUTATIONAL FLUID DYNAMICS	DE	3-0-0	3
	MEP435	COMPUTATIONAL FLUID DYNAMICS	DE	0-0-2	1
3	MEL420	FINITE ELEMENT METHOD	DE	3-0-0	3
	MEP420	FINITE ELEMENT METHOD	DE	0-0-2	1
4	MEL410	COMPUTER AIDED DESIGN	DE	3-0-0	3
	MEP410	COMPUTER AIDED DESIGN	DE	0-0-2	1
5	MEL436	MECHATRONICS	DE	3-0-0	3
	MEP436	MECHATRONICS	DE	0-0-2	1
	Elective (Any four)				
6	MEL407	BIO MECHANICS	DE	3-0-0	3
7	MEL414	TRIBOLOGY	DE	3-0-0	3
8	MEL433	DESIGN FOR MANUFACTURING AND ASSEMBLY	DE	3-0-0	3
9	MEL412	AIR CONDITIONING	DE	3-0-0	3
10	MEL431	ADVANCED MECHANISM	DE	3-0-0	3
11	MEL437	COMPOSITE MATERIALS	DE	3-0-0	3
12	MEL408	SUPPLY CHAIN MANAGEMENT	DE	3-0-0	3
13	MEL425	RELIABILITY AND MAINTENANCE ENGINEERING	DE	3-0-0	3
14	MEL440	MACHINE VISION & ITS APPLICATION	DE	3-0-0	3
15	MEL452	ADVANCED MACHINING PROCESSES	DE	3-0-0	3

16	MEL417	POWER PLANT ENGINEERING	DE	3-0-0	3
17	MEL402	SURFACE ENGINEERING	DE	3-0-0	3
18	MEL***	ADVANCED MECHANICS OF SOLIDS	DE	3-0-0	3
19		OC/HM	DE	3-0-0	3
	Elective Credits = 16				
	DC + DE = 18 Credits				

Semester VIII

Sr.No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MED402	PROJECT PHASE-II	DC		4
	Core Credits = 4				
	Elective (Any one)				
2	MEL426	REFRIGERATION & CRYOGENICS	DE	3-0-0	3
	MEP426	REFRIGERATION AND CRYOGENICS	DE	0-0-2	1
3	MEL430	ADVANCED IC ENGINE	DE	3-0-0	3
	MEP430	ADV. I. C. ENGINE	DE	0-0-2	1
4	MEL445	AUTOMATION IN PRODUCTION	DE	3-0-0	3
	MEP445	AUTOMATION IN PRODUCTION	DE	0-0-2	1
	Elective (Any five)				
5	MEL443	AIR POLLUTION CONTROL	DE	3-0-0	3
6	MEL449	ADVANCED TURBO MACHINERY	DE	3-0-0	3
7	MEL401	CONTROL SYSTEMS	DE	3-0-0	3
8	MEL424	INDUSTRIAL ENGINEERING & MANAGEMENT	DE	3-0-0	3
9	MEL428	MACHINE TOOL DESIGN	DE	3-0-0	3
10	MEL403	OPERATION RESEARCH	DE	3-0-0	3
11	MEL448	ARTIFICIAL INTELLIGENCE IN MANUFATURING	DE	3-0-0	3

12	MEL413	FRACTURE MECHANICS	DE	3-0-0	3
13	MEL454	QUALITY ENGINEERING MANAGEMENT	DE	3-0-0	3
14	MEL418	ADVANCED STRESS ANALYSIS	DE	3-0-0	3
15	MEL405	OPTIMIZATION	DE	3-0-0	3
16	MEL444	SOLAR ENERGY UTILIZATION	DE	3-0-0	3
		OC/HM	OC/HM	3-0-0	3
	Elective Credits = 19				
	DC + DE = 23Credits				

List of Open Courses (offered by the department)

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MEL446	PRODUCT DESIGN	OC	3-0-0	3
2	MEL447	ENGINEERING ECONOMICS	OC	3-0-0	3
3	MEL455	VALUE ENGINEERING	OC	3-0-0	3
4	MEL453	ENGINEERING PRODUCT DEVELOPMENT	OC	3-0-0	3
5	MEL450	COST ACCOUNTING	OC	3-0-0	3

III SEMESTER

MEL203 ENGINEERING THERMODYNAMICS

4 credits (3-1-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : On completion of this course, students will be

1. Able to understand the fundamental of the first and second laws of thermodynamics and their application to a wide range of systems.

2. Able to analyze the work and heat interactions associated with a prescribed process path, and to perform a first law analysis of a flow system.

3. Able to evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.

4. Familiar with the construction and principles governing the form of simple and complex one-component pressure-temperature diagrams and the use of volume-temperature and pressure-volume phase diagrams and the steam tables in the analysis of engineering devices and systems.

5. Familiar with the fundamental of the air standard cycles and their applications.

Content:

Basic Concepts

Introduction to Thermodynamics Basic concept of thermodynamics, Closed and open systems, Forms of energy, Properties of system, State and equilibrium, processes and cycles, Temperatures and Zeroth law of thermodynamics. Introduction to First law of Thermodynamics (Law of conservation of Energy), Heat and work, Mechanical forms of work, non-mechanical forms of work (Electrical, Magnetic etc.) ,Ideal gas equation of states, Difference between Gas and vapor, compressibility Factor, Internal energy and specific heats of gases, Universal Gas constant.

First Law of Thermodynamics

First Law of thermodynamics, Closed system (control mass system), work done, change in Internal energy, heat transferred during various thermodynamic processes, P-V diagrams. Open system (control mass system), Thermodynamic analysis of control volume Conservation of

energy principle, flow work and enthalpy The steady flow process applied to (i) Nozzles and Diffuser (ii) Turbines and Compressor, (iii) Throttle valve Unsteady flow process (Simple system like Charging & Discharging of tanks).

Second Law of Thermodynamics

Second law of Thermodynamics Introduction (Law of degradation of Energy) Thermal Energy reservoir, Kelvin-Plank &Clausius Statement, Heat engine, Refrigerator and Heat pump, Perpetual motion machines, Reversible and Irreversible processes, Carnot cycle, Thermodynamic temperature scale. Entropy: The Clausius inequality, Entropy Principle of increase of entropy, Change in entropy for Closed and steady flow open systems. Second law analysis of engineering system, Availability, reversible work & Irreversibility.

Properties of Steam

Critical state, sensible heat, Latent heat, Super Heat, Wet Steam, Dryness fraction, Internal energy of steam External work dine during evaporation, T-S diagram Mollier Chart. Work and heat transfer during various thermodynamic processes with steam as working fluid Determination of dryness fraction using various calorimeters.

Air Standard Cycle

Air standard cycle: Otto cycle Sterling and Ericsson cycle, Brayton cycle Vapor cycle: Simple and Modified Rankine cycle with reheat & regeneration.

I.C. Engines and Compressors

Introduction to Internal combustion engine e.g. Two stroke, Four stroke cycle, engine components, their comparison,Wankel engine, and their efficiencies, Introduction to Single stage reciprocating compressor and its efficiencies.

Text Books/ Reference Books:

1. Nag P.K. “Engineering Thermodynamics”, Tata McGraw- Hill, 3rd Edition, 2002.
2. Reyner Joel. “Engineering Thermodynamics”, Addison Wesley, 5th Edition, 1999.
3. Arora C.P. “Thermodynamics”, Tata McGraw- Hill, 1st Edition, 2001.
4. Thombre S.B. “A data book on Thermal Engineering”, Green Brains Publication, 1st Edition, 2003.

MEL204 ENGINEERING METALLURGY

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

On completion of this course, students will be

1. Able to describe the basic elements of material science and its application to engineering fields.
2. Able to establish their understanding for crystal structure, phase diagrams and their applications, principles of solidification of metal.
3. Able to explain the concept of phase diagrams, solidification principles and engineering of ferrous and non-ferrous materials.

Content:

Classification of materials, Properties and applications of materials crystalline nature of materials, especially microscopic examinations of metals. Alloys and solid solutions, types and their formations, modified Gibb's Phase rule, Lever rule for phase mixtures and their application in system.

Study of equilibrium diagram and invariant reactions, Iron-Iron carbide equilibrium diagram, critical temperatures, microstructure of slowly cooled steels, Estimation of carbon from microstructures, structure property relationship. Classification and application of steels, Effect of alloying elements, Specification of some commonly used steels for Engineering applications (e.g. En. AISI, ASTM, IS etc.) with examples.

Classification and application of plain carbon steels. Examples of alloy steels such as high manganese steel, Ball bearing steels, maraging steels, spring steels, etc.

Tool steels-classification, composition, application and commercial heat treatment practice for

HSS, secondary hardening. Stainless steels- classification, composition, application and general heat treatment practice for stainless steels.

Heat Treatment and its importance, annealing, Normalizing, Hardening, Quench Cracks, Hardenability test TTT Diagram and its construction and related Heat Treatment Processes such as Austempering, Martempering, patenting etc. Retention of austenite, Effects and elimination of retained austenite, Tempering case/ Surface hardening treatments such as carbonizing, Nitriding, Cyaniding, Carbonitriding. Flame and Induction hardening.

Cast Iron- Classification, White Cast Iron, Gray Cast Iron, Nodular Cast Iron, Malleable Cast Iron, and Chilled and alloy Cast iron. (Production route, Composition, Microstructure and applications) Effects of various parameters on structure and properties of Cast Iron, Alloy Cast Iron such as Ni resist Ni hard.

Non-Ferrous Alloys: Study of non-ferrous alloys such as brasses (Cu-Zn diagram), bronzes (Cu-Zn diagram), Aluminum alloys (e.g. Al-Si and Al-Cu diagram), bearing materials.

Tension Test: Engineering and True stress strain curve, conversion relationship, evaluation of properties, numerical based on tension and compression test, Types of engineering stress strain curves, compression test. Hardness test- Brinell, Vickers, And Rockwell.

Introduction to Charpy and Izod Impact Test, Introduction to Non Destructive Testing.

Text Books/ Reference Books:

1. Avner S. “Introduction to Physical Metallurgy”, Tata McGraw Hill, 2nd Edition, 2001.
2. Lakhtin Y. “Physical Metallurgy & Heat Treatment”, Mir Publishers, 6th Edition, 1998.
3. Rollason E.C, “Introduction to Engineering Metallurgy”, Edward Arnold publications, 1959.
4. Agrawal B.K. “Introduction to Engineering Materials”, Tata McGraw Hill, 1st Edition, 2007.

MEP204 ENGINEERING METALLURGY

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

1. Students will be able to learn and practice preparation, identification of micro structure and understand basic mechanical tests.

Content:

A set of 10 Experiments from following list

1. Study of Metallurgical Microscope.
2. Preparation of specimen for metallographic examinations.
3. Preparation of Mounted sample with the help mounting press/ cold setting resins.
4. Study and drawing of microstructures of steels.
5. Study and drawing of microstructures of cast iron.
6. Study and drawing of microstructures of non-ferrous metals.
7. Study of the effect of annealing and normalizing on the properties of steel.
8. Determination of hardenability of steels by Jominy End Quench Test.
9. Tensile Test on mild steel and aluminum test specimen.
10. Measurement of Hardness of ferrous and non-ferrous materials with the help of
    - Brinell
    - Vickers
11. Rockwell Testing machine.
12. Study the heat treatment of High Speed Steels.
13. Study the heat treatment of Stainless Steels.
14. Study of effect of Alloying element on Properties of Steels.
15. Study of Macroscopic examination.
16. Study of Mechanisms of Quenching.

17. Study of Pack carburizing of steel samples.

18. Impact Test.

Text Books/ Reference Books:

MAL201INTEGRAL TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

4 credits (3-1-0)

Pre-requisites:NIL

Overlaps with:

Course Outcomes/ Objectives : On completion of this course, students will be

1. Able to apply knowledge of mathematics, science and engineering in the solution of Mechanical Engineering problems.
2. Able to demonstrate an ability to identify, formulate, analyze and solve Mechanical Engineering problems.
3. Able to demonstrate ability to design mechanical systems, conduct experiments, analyze and interpret the resulting data.
4. Able to demonstrate an ability to design a system, component to meet desired needs within the context of Mechanical Engineering and considering realistic constraints.

Content:

Differential Equation :Solution of Ordinary differential equation of higher order, Frobenius method, Legendre equation, Bessel equation, Legendre Polynomials, Bessel function of first and second kind.

Laplace Transform: Definition & its properties, transform of derivatives and integrals, evaluation of integrals by Laplace Transform. Inverse Laplace Transform, convolution theorem, Laplace transform of periodic function and unit step function and dirac delta function, application of Laplace transform to solve ordinary differential equation and partial differential equation-One-

dimensional wave and heat equation.

Partial Differential Equation: Partial differential equation of first order. Linear homogeneous partial differential equation of nth order with constant coefficient, Method of separation of variables, application to simple problem of vibration of strings and beam, to simple of vibration of rectangular membrane and one dimensional heat equation.

Fourier Series: Introduction, the Fourier theorem, Evaluation of Fourier coefficients, Half Range series, considerations of symmetry, Exponential form of Fourier series, Fourier integral theorem, Fourier transform, Elementary concept of double Fourier Series.

Complex Variable :Analytical function, Cauchy-Riemann conditions, conjugate functions, singularities, Couchy's integral theorem and integral formula, Taylor's and Laurent's theorem, Residue theorem, Evolution of integral by residue theorem, Conformal mapping, mapping by Linear and Inverse transformation.

Text Books/ Reference Books:

1. Speigel M. R. "Advanced Mathematics For Engineers and Scientists", McGraw Hill, 2nd Edition, 1992.

2. Chandrika Prasad. "Mathematics for Engineers", Prasad Mudranalaya, 12th Edition, 1981.

3. Kreyszig E. "Advanced Engineering Mathematics", John Wiley & Sons, 7th Edition, 1993.

MEL206 SOLID MECHANICS

4 credits (3-1-0)

Pre-requisites: Nil

Overlaps with:

Course Outcomes/ Objectives : On completion of this course, students will be

1. Able to understand the theory of elasticity including strain/displacement and Hooke's law relationships.
2. Able to analyze solid mechanics problems using classical methods and energy methods;
3. Able to analyze the stresses and deflections of beams under various loading conditions.
4. Able to solve torsion problems in bars and thin walled members.
5. Able to obtain solutions to column buckling and plate problems.
6. Able to apply various failure criteria for general stress states at points.

Content:

Introduction, stress, strain, types of stresses, stress strain diagram, hooke's law, analysis of composite section, thermal stresses and strain, thermal stresses, longitudinal stress and strains, lateral stress and strain, poisons ratio, volumetric stresses and strain with uni-axial, bi-axial and tri-axial loading, bulk modulus, relation between Young's modulus, and modulus of rigidity, poison's ratio and bulk modulus.

Principal stress and strain: - Analytical method, Mohr's circle for representation of stresses, derivation of maximum and minimum principal stresses and maximum shear stresses when member is subjected to different types of stresses simultaneously (i.e. combined stress).

Types of beam (cantilever, simply supported, overhang beam etc.), types of load (concentrated and UDL), shear force and bending moment diagram for different types of beams subjected to different types of loads.

Stresses in beam: pure bending, theory of simple bending with assumption and expression for bending stresses, derivation of bending equation, bending stresses in symmetrical sections, section modulus for various shapes of beam sections.

Shear stresses in beams: Derivation of differential equation of elastic curve with the assumptions made in it, deflection and slopes of cantilever, simply supported, overhang beams subjected to concentrated load, UDL, relation between slope deflection and radius of curvature, Macaulay's method, Area-Moment method to determine deflection of beam.

Derivation of torsion equation with the assumptions made in it, torsion shear stress induced in the shaft when it is subjected to torque, strength and rigidity criteria for design of shaft, torque transmitted for solid and hollow circular shaft, derivation of maximum, minimum principal stresses and maximum shear stress induced in shaft when it is subjected to bending moment torque and axial load.

Column and struts: Failure of long and short columns, slenderness ratio, assumptions made in Euler's column theory, end conditions for column, expressions for crippling load for various end conditions of column, effective length of column, limitations of Euler's formula, Johnson's parabolic formula

Definition of strain energy stored in a body when it is subjected to gradually applied load, suddenly applied load sand impact loads, strain energy stored in bending and torsion.

Factor of safety, statistical method of determining factor of safety, theories of failure, modes of failure, Compound stresses, eccentric axial loading, variable stresses in machine parts stress concentration and stress raiser, notch sensitivity, stress concentration factor, methods of reducing stress concentration, Goodman's criteria, soderberg's criteria, Garber's criteria, fatigue design for finite and infinite life of parts subjected to variable loads.

1. Two problems on principal stresses.

2. Two problems on Mohr's circle.

3. Two problems on thermal stresses with heat flow.

4. Two problems on SF and BM diagram.

5. Two problems on stresses in beam bending

6. Two problems on shear stresses.

7. Two problems on Macaulay's method.

8. Two problems on Area –Moment method.

9. Two problems on shafts.

10. Two problems on columns and struts.

11. Two problems on compound loading.

12. Two problems on fatigue and variable loads.

Text Books/ Reference Books:

1. Shames I.H. "Introduction to Solid Mechanics", PHI Publication, 3rd Edition, 2002.

2. Ragab A.R. "Engineering Solid Mechanics", CRC Press, 2nd Edition, 1998.

3. Beer F.P., Johnston E.R. "Mechanics of Materials", TaTa McGraw Hill Publication, 3rd Edition, 2004.

MEL201 Theory of Machine – I

4 credits (3-1-0)

Pre-requisites: NIL

Overlaps with:

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

1. Analyze planer mechanisms terms of DoF, Gross Motion, Velocity and Acceleration of Points on Link / Links, Forces acting on links and joints.
2. Synthesize simple mechanisms.
3. Analyze and synthesis cams, gears and gear trains.
4. Analyze and determine key kinematic parameters for friction mechanisms.

Mapping with POs:

POs	a	b	c	d	e	f	g	h	i	j	k

→ COs ↓											
CO1	H	H	H	-	H	-	H	L	H	L	H
CO2	H	H	H	-	H	-	H	L	H	L	H
CO3	H	H	H	-	H	-	H	L	H	L	H
CO4	H	H	H	-	H	-	H	L	H	L	H
Overall	H	H	H	-	H	-	H	L	H	L	H

Content:

Basics: Basic concepts of mechanisms, links, kinematic pairs, kinematic chain, mechanisms, machine, Types of mechanisms, Degree of freedom of link and planer mechanism.

Analysis: Classification of four-bar chain (Class I and Class II) Inversion of four bar chain, slider crank chain and double slider crank chain along with their gross motion analysis. Velocity, acceleration analysis of planer mechanism by graphical method using relative velocity/ acceleration. Concept of velocity and acceleration image, Coriollis component of acceleration, Instantaneous centre of velocity method. ----- CO1

Synthesis: Synthesis of four-bar/ slider crank mechanism for gross motion. Input/ Output coordination and quick return ratio. Transmission angle. ----- CO2

Cam Mechanisms: Types of cams, follower and applications. Synthesis of cam for different types of follower motion like constant velocity, parabolic SHM, cycloidal etc. Construction of eccentric cam, tangent cam and circular arc cam. Analysis of follower motion for cams with specified contours like eccentric cam, tangent cam and circular arc cam.

Gears: Types of gears, Gear tooth terminologies. Concept of conjugate action, law of conjugate action, kinematics of involute gear tooth pairs during the contact, number of pairs of teeth in contact, path of approach and path of recess Interference, undercutting for involute profile teeth. Introduction to cycloidal profile. Types of gear trains. Kinematic analysis of gear trains including simple epicyclic and double epicyclic gear trains. ------ CO3

Friction Devices: Ratio of belt tension, initial tension for flat and V belts. Theory of Friction, Efficiency and torque required to raise and lower load in a nut and screw mechanism. Types of brakes and braking torque relations and Dynamometers. Types of pivots and clutches alongwith relations for torque transmitted -------- CO4

Force Analysis: Static force analysis of all links of given linkages, cams, gears mechanism and their combinations without friction and with friction. Force analysis of gear trains. Concept of inertial load. Dynamic force analysis of lower pair mechanisms and cam follower mechanisms. --------- CO1

Text Books/ Reference Books:

1. Shigley J.E., Uiker J.J "Theory of Mechanisms & Machines", McGraw Hill Int., 1985.
2. ThomosBeven "Theory of Mechanisms &Machinesrs", CBS Publisher
3. Rao J.S., Dukki Patti R.V "Mechanisms & Machines Theory,",New age Int, 2nd 1998.
4. Ghosh A, Mallik A "Theory of Mechanisms & Machines, Ed", Aff. East-West Press, 3rd 1998.
5. Rattan "Theory of Machine", Tata McGraw Hill, 1995.
6. Sandor G.N., Erdman A.G"Theory of Machines", Prentice Hall Publications, 1984 .

IV Semester

MEL202FLUID MECHANICS

4 credits (3-1-0)

Pre-requisites: Nil

Overlaps with:

Course Outcomes/ Objectives :

Students successfully completing this course will demonstrate the following outcomes by homework and exams:

1. An understanding of fluid mechanics fundamentals, including concepts of mass and momentum conservation.
2. An ability to apply the Bernoulli equation to solve problems in fluid mechanics.
3. An ability to apply control volume analysis to problems in fluid mechanics.
4. An ability to use potential flow theory to solve problems in fluid mechanics.
5. An ability to perform dimensional analysis for problems in fluid mechanics.
6. A knowledge of laminar and turbulent boundary layer fundamentals.

Content:

Introduction : Properties of fluids, viscosity, capillarity and surface tension, Fluid pressure and its measurement Pressure variation in compressible and incompressible fluids, Hydrostatics: Forces on plane and curved surfaces, Buoyancy, Stability of floating and submerged bodies, Relative equilibrium pressure distribution in liquid subjected to acceleration and rotation.

Flow Kinematics: Types of flows; steady and unsteady, rotational and irrotational, laminar and turbulent, etc Streamlines, potential lines, flow net, vortex motion, Velocity and acceleration at a point, stream function, potential function, continuity equation, Bernoulli's equation and its applications.

Measurement of Fluid Flow: Through ducts: Orifice meter, venturi meter, rotameter, etc., Through open channels: Triangular notch, Rectangular notch, trapezoidal notch, etc., Through reservoirs: Orifice, mouthpiece, etc.

Viscous Flow : Through pipes and parallel plates (Hagen poiseuille and plane poiseuille flow) Boundary layer concept, boundary layer thickness, wall shear, displacement thickness, momentum thickness and energy thickness, integral equation,Boundary layer separation.

Flow Through Pipes: Major and minor losses, friction chart, Pipes in series and parallel, Siphon, Power transmission Hydraulic Gradient Line and Total Energy Line

Compressible Flows: Introduction to compressible flows, speed of sound wave, Mach number, Mach cone, one dimensional isentropic flows, stagnation properties, flow through nozzles, normal shock

Text Books/ Reference Books:

1. White F.M "Fluid mechanics; Ed", McGraw Hil, 2nd1986.
2. Massey B.S. "Mechanics of fluids", ELBS-Chapman & Hall, 6th Ed1994.
3. Streeter V.L, Wylie E.B "Fluid mechanics, 7th Ed;,", McGraw Hill, 1983.
4. Thombre S.B. "A data book on Thermal Engineering", Green Brains Publication, 1st 2003.

MEP202 FLUID MECHANICS

1 credits (0-0-2)

Pre-requisites: Nil

Overlaps with:

Course Outcomes/ Objectives :

1. To understand the basic concepts regarding the behaviour of fluid.
2. To learn various methods for estimation of forces due to fluid / fluid pressure measurement and flow measurements.
3. Develops skill to analyze various fluid systems.

Content:

1. Determination of viscosity of a fluid by falling sphere method
2. Study of manometers
3. Study of pressure variation along the depth in an incompressible fluid
4. Study of vortex motion
5. Determination of metacentric height of a ship model

6. Tracing of stream lines

7. Verification of Bernoulli's equation

8. Determination of drag and lift coefficients

9. Determination of coefficient of discharge of a venturi/ orifice meter

10. Determination of coefficient of discharge of an orifice/ mouthpiece

11. Determination of coefficient of discharge of different notches

12. Study of Hagen Poiseuille flow

13. Reynolds experiment

Other experiments based on the theory syllabus

Text Books/ Reference Books:

MEL207 MANUFACTURING PROCESSES- I

3 credits (3-0-0)

Pre-requisites: Nil

Overlaps with:

Course Outcomes/ Objectives : On completion of this course, students will be

1. Able to understand the behavior and properties of materials as they are affected by manufacturing processes.

2. Able to apply knowledge of manufacturing processes and the skills to develop and manipulate the operating parameters for a given process.

3. Able to examine the principles associated with basic operations involving the forming and welding of engineering materials.

4. Able to analyze the basic processes used in mechanical working of metals and welding operations on engineering materials.

Content:

Pattern Making : Casting Processes, Pattern making, pattern materials, Types of pattern, Removable and disposable pattern, pattern allowances, color codes of pattern. Moulding Sands: Types of Moulding sands, properties of moulding sand. Moulding: Types of Moulds, Tools used in moulding, Procedure for making moulds, Moulding process, Types of moulding operations. Cores: Properties of cores, types of cores, core making, chaplets.

Casting : Elements of gating system, Types of gating, risering, Melting and pouring of metals,Melting Furnaces: Electric arc furnace, Cupola furnace, Induction furnace, oil fired tilting furnace. Defects in sand casting: blowholes, shrinkage defect, hot tears. Mis-runs, cold shut, and pour short, Inclusions. Special casting processes: Plaster mould casting processes, shell moulding casting processes, permanent mould casting processes, die casting processes, continues casting processes, centrifugal casting processes, Advantages and limitations of casting processes, selection of casting process. CO2 moulding, Investment casting.

Mechanical Working of Metals:

Mechanical Working of Metals: Hot rolling, hot spinning, wire drawing. Metal Forming Process: Rolling Processes, rolling operation, terminology used in rolling, rolling mills, thread rolling, Extrusion Process: Types of extrusion, extrusion pressure in direct and indirect extrusion.

Forging Processes: Forging materials, classification of forging operations, types of forging operations. Power forging, Impression die forging, press forging, roll-die forging, and defects in forging, Rotary swaging. Defects in forging. Surface Coating of Metals: Cleaning methods of metals, buffing, and electroplating, anodizing, plastic coating.

Sheet Metal Working: Introduction, Punches and dies, sheet metal working operations: piercing and punching, blanking, notching, beading, flanging, hemming, seaming, perforating, slitting, lancing, mechanism of blanking, drawing, coining, embossing, wire drawing, metal spinning.

Powder Metallurgy and Processing of Plastics: Introduction, Methods of manufacturing powders, production of metal powder, mixing of powders, compaction, sintering, secondary operation, advantages and limitation of powder metallurgy. Processing of Plastic: Introduction, general properties and applications, types of plastic, thermosetting plastic, thermo-plastic plastics. Forms of raw plastic material: Powder form, laminated sheets and rods, fibers, resins, Methods of processing plastics: compression molding, injection molding, extrusion, Calendaring, wire drawing.

Welding: Metal joining processes: Introduction, classification of joining processes. Welding process: Types of welding processes, pre-welding requirements, and welding, welding technique, types of welding joints, edge preparation for welding, welding techniques. Arc welding: electron theory of arc columns, arc-welding process, weld penetration, Gas welding: Gas welding process, Types of flames, fluxes, filler material. Resistance Welding: Spot welding, seam welding, tungsten inert gas (TIG) welding, Metal Inert gas welding (MIG). Soldering and brazing, Thermit welding.

Mechanical Fasteners: Threaded fasteners, non-threaded fasteners.

Text Books/ Reference Books:

1. Rao P.N. "Manufacturing Technology: Metal cutting & Machine Tools", McGraw Hill Publication, 3rd Edition 2013.

2. Ghosh A., Malik A.K. "Manufacturing Science", Affiliated East-West Press Ltd, 1st Edition, 2001.

3. HajraChoudhari. "Workshop Technology", Media Promoters & Publishers, 13th Edition, 2010.

4. Kalpakjian S., Schmid S.R. "Manufacturing Engineering & Technology", Pearson Edu Asia, 4th Edition, 2000.

5. Krar, Oswald. "Technology of machine Tools", McGraw Hill New York, 1st Edition, 1976.

6. Begman M. "Manufacturing Processes", Texas Publication, 1st Edition, 1956.

7. HMT. "Production Technology", Tata Mcgraw Hill Publication, 1st Edition, 1980.

8. Bawa H. S. "Workshop Technology", Tata McGraw Hill Publication, 1st Edition, 2001.

MEL304 MACHINE DESIGN – I

3 credits (3-0-0)

Pre-requisites: Nil

Overlaps with:

Course Outcomes/ Objectives :

On completion of this course, students will be able to

(a) The graduates will be able to apply knowledge of basic sciences (math, physics, chemistry etc.) and engineering (core and elective subjects) in getting solutions to mechanical engineering related problems.

(b)The graduates will be able to design and conduct experiments as well as analyze and interpret data.

(c) The graduates will be able to design a system or a component of a system for a specific task within realistic constraints.

(d) The graduates will be able to formulate and apply the knowledge of mathematical techniques in solving the governing equations of a system under consideration.

1. Identify the basic design strategies and theories for machine component design
2. Identify various failures and calculate resisting areas of machine elements.
3. Design machine element subjected to direct, bending, twisting and combined stress.
4. Solve problems on power transmission.
5. Design of thin and thick cylinder pressure vessel.
6. Design for Fatigue and cyclic loads.

Mapping with Pos:

Pos → Cos ↓	a	b	c	d	e	f	g	h	i	j
CO1	L	H	L	L	H	-	-	-	-	-
CO2	H	L	H	M	H	-	-	-	-	-
CO3	L	M	H	H	M	-	-	-	-	-
CO4	M	M	M	M	M	-	-	-	-	-
CO5	L	M	M	L	L	-	-	-	-	-
CO6	M	M	M	L	M	-	-	-	-	-
Overall	M	M	M	M	M	-	-	-	-	-

Content:

Design Principles : Definition of design, types of design, design process, need, defining the problem, feasibility, preliminary design alternatives, final design selection, preliminary and final

plans and drawings. Failure criterion & manufacturing considerations in design, basis of good design, theories of failure and factor of safety, wear, corrosion, manufacturing methods, machining tolerance, surface finish, cost design consideration in casting & forging. Material Selection: Mechanical properties, Applications and designations as per ISI and their equivalence with other standards of engineering materials, selection of material, temperature effects on material properties of ferrous and non-ferrous materials, plastics, composites & their applications. (CO1)

Joints : Design of Joints : Design of cotter and knuckle joint, shrink and press fit joints. Riveted Joint: Riveted joints for boilers, structural works (uniform strength joint), and eccentric loaded joint. Welded Joint: Design of single transverse, double transverse, parallel fillet, combination fillets butt joint, eccentrically loaded welded joints. Bolted Joint: Design of bolted fasteners, bolts of uniform strength, bolted joints under eccentric loading. Design of lever and pin joints: Hand lever, Foot lever, and Bell Crank lever. (CO2,CO3)

Design of Springs , Design of Power screws : Forms of threads; square, Acme & Trapezoidal threads, efficiency of various threads form. Design of screw jack and compounded screws.

Design of Springs, Expression for deflection and shear stress in helical spring, design of helical spring, design of leaf spring. (CO4)

Design of pressure vessels: Classification of thin & thick cylindrical pressure vessel, stresses in thin & thick cylindrical pressure vessel when it is subjected to internal pressure, expression for circumferential & longitudinal stresses, designs of pressure vessel, heads & cover plate. (CO5)

Design For Fatigue and Cyclic loads: Fatigue failure, S-N curve, Stress concentration factor, Fatigue stress concentration factor, Failure for cyclic and variable loads, Goodman's Line, Soderberg's line, Gerber parabola (CO6)

Text Books/ Reference Books:

1. Maleev V.L, Hartman J.B "Mechanical Design of Machine", CBS Pub. &distributors.,1983.
2. Black P.H., Adams O.E "Machine Design, Tata McGraw Hill, 1968.
3. Shigley J.E "Mechanical Engg. Design", Tata McGraw Hill International, 8th Edition.
4. Shiwalkar B.D "Design of Machine Elements, Ed", Central Techno Publication, 2nd 2001.
5. Shiwalkar B.D "Design Data for Machine Elements", Central Techno Publication.
6. PSG College of Technology "Design data", DPV Printers, Coimbature, 2011 .
7. V. B. Bhandari "Design of Machine Elements", Tata McGraw Hills, 3rd, 2013.

MEL301 Theory of Machine – II

3 credits (3-0-0)

Pre-requisites: Nil

Overlaps with:

Course Outcomes/ Objectives :

On completion of this course, students will be

1. Students will have an understanding of static force relationships and inertia forces and their effect that exist in machines
2. Students will demonstrate the dynamics of flywheel and their motion
3. Students will be able to perform balancing, vibration and critical speeds with respect to Machine dynamics

Content:

Machine Dynamics : Concepts in machine element dynamics. D'Alembert principle and inertia forces. Unbalance forces and moments in rotor-disc assembly. Static and dynamic balancing by analytical as well as graphical method. Field balancing by vector diagram and by influence coefficient method.

Balancing of reciprocating masses : Dynamic force analysis of reciprocating mechanism by analytical method. Primary and secondary inertia forces. Balancing of inertia forces in reciprocating mechanism. T-ς□diagram for single- cylinder and multi-cylinder engines and other reciprocating machines such as punching press. Selection of Flywheel inertia parameters. Balancing of inertia forces and couples in multi-cylinder engines. Selection of firing order and crank diagram. Radial engines and V-twin engines. Gyroscopic effect in machines such as ship, vehicles, grinding mills.

Vibration : Basic methods of mathematical modeling of discrete vibratory systems. Free body diagram, Rayleigh energy method and Langrange equation. Laplace transform and transfer function derivation. Free vibration of single DOF systems. Estimation of Damping. Forced vibration under harmonic excitation. Impulse and step response. Modeling of two DOF systems.

Torsional vibrations of rotors. Whirling of shaft and critical speed. Modeling of multi-degree of freedom system mode orthogonality property. Natural frequency and mode shape calculation by matrix iteration method. Modal analysis. Free and forced vibration.

Text Books/ Reference Books:

1. Ghosh & Malik. “Theory of Mechanism and Machine, ”,Aff. East-West Press, Anand ,3rd.

2. Ratan ,"Theory of Machine,; ",Tata McGraw Hill, 12th Reprint Edition .

3. Rao,Gupta"Theory and Practice of Mechanical Vibration,",New Age International,2nd Ed.

4. MeirovitchL."Elements of Vibration Analysis,"McGraw Hill Publications,2nd Ed .

MEP301 Theory of Machine – II

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :On completion of this course, students will be

1. Students will have an understanding of static force relationships and inertia forces and their effect that exist in machines

2. Students will demonstrate the dynamics of flywheel and their motion

3. Students will be able to perform balancing, vibration and critical speeds with respect to Machine dynamics

Content:

- Determination of jump-of speed of a typical cam-follower system.
- Dynamic balancing of rotating masses.
- Balancing of reciprocating mechanism.
- Critical speed of shafts.
- Gyroscope
- Free vibration of single DOF and two DOF spring mass system.
- Natural frequency determination of cantilever beam.

- Damping determination through free vibration logarithmic decay of simple damped system.
- Natural frequency determination of two & three rotor system.
- Torsional vibration of bifilar or trifilar pendulum.
- Transmissibility of single DOF system.
- Dynamic vibration absorber.
- Dynamic force analysis of four bar mechanisms.
- Dynamic force analysis of slider crank mechanism.
- Flywheel selection and parameter design for a typical multi cylinder engine.

Performance characteristics of governors.

Text Books/ Reference Books:

MEL303 ENERGY CONVERSION – I

4 credits (4-0-0)

Pre-requisites: NIL

Overlaps with:

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

1. Classify boilers and prepare heat balance for the boiler performances.
2. Apply change cycles for thermal power plants.
3. Analyze the performance of steam turbines.
4. Describe the performances for steam nozzles, steam condensers and cooling towers.

Mapping with POs:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	H	H	H	L	M	L	H	M	H	L	L
CO2	H	H	H	L	M	L	H	H	H	M	H
CO3	H	H	H	M	H	L	H	M	H	M	H
CO4	H	H	H	L	M	L	H	M	H	M	H
Overall	H	H	H	L	M	L	H	M	H	M	H

Content:

Steam Generators

Principles of steam generation, Classification of Steam Generators, Fire tubes and Water tubes Steam Generators, High Pressure and Super critical Steam Generators, Boiler Mountings and Accessories.

Draught

Draught and its classification, Chimney height, Chimney Efficiency, Condition for maximum discharge.

Performance of Steam Generators: Evaporative Capacity, Equivalent Evaporation, Factor of Evaporation, Boiler Efficiency, Energy balance.

Fluidized Bed Boilers

Fluidized Bed Boilers: Bubbling Fluidized Bed Boiler, Circulating Fluidized Bed Boiler, Introduction to Cogeneration and Combined Cycles, Power Plants.

Steam Nozzles: Adiabatic expansion in nozzles, Maximum Discharge, Critical Pressure Ratio and effects of Friction, Calculation of throats and exit area, Super Saturated flow, Wilson's line.

Steam Turbines: Principles of Working of Steam Turbines, Classifications of Steam Turbine, Comparison of Impulse and Reaction Turbines, Simple and Compound Steam Turbines. Energy losses in Steam Turbines, Flow of steam through Turbine blading, Actual Reheat factor, Velocity diagrams, Graphical and analytical Methods, Work done, Thrust and Power, Dimensions and Proportioning of the Blades, Steam Turbine, Efficiencies, Condition for Maximum Efficiency, Reheat and Regenerative cycles, Governing of Steam Turbine.

Steam Engines

Introduction to Simple Steam Engine. Modified Rankine Cycle.

Steam Condensers and Cooling Towers

Steam Condensers and Cooling Towers: Types of Condensers, Classification of Condenser, Quantity of cooling water Required, Design Calculations for Surface Condenser, Daltons Law of Partial Pressures, Sources of Air Leakage and Air Removal. Wet and Dry Pumps, Air Ejectors, Cooling Towers, Cooling Ponds.

Tutorials:

1. High pressure boilers
2. Meta-stable flow in steam nozzles

3. Governing of steam turbines

4. Blade design in steam turbines

5. Cooling Towers and cooling ponds

6. Design aspects of steam condenser.

Text Books/ Reference Books:

1. Domkundwar, K'raman, Khajuria "Thermal Engineering", Dhanpatrai& sons, 4 th 1996.

2. Ballaney P.L "Thermal Engineering ", Khanna Publishers, 24 th 2003.

3. Rogers, Mayhew "Engineering Thermo: Work and Heat Transfer", Longman, London, 1992.

4. Kearton V.J "Steam Turbines", The English Language Book Society, London, 1961.

5. Thombre S.B, Roy H "A data book on Thermal Engineering", Green Brains Publication, 1 st 2003.

MEP207 MANUFACTURING PROCESSES- I

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

1. To understand different manufacturing process and select the best one out of the available methods.

2. To understand the design for manufacturability

Content:

Pattern Making Shop:

1. Study of various joints used in pattern making.

2. Study of different wood working machines.

3. Study of various tools used in pattern making.

4. Study of various pattern allowances

5. Practice of making a pattern.

Foundry Shop:

1. Study of different furnaces (i.e. Cupola, Electric arc, Induction, Tilting etc.)

2. Study of different types of pattern.

3. Study of different types of Foundry tools.

4. Study of different types of sands and their properties.

5. Practice of making green sand mould.

Welding Shop:

1. Electric Arc Welding.

2. Resistance welding.

3. Gas welding.

4. Gas cutting.

Sheet Metal Working.

Text Books/ Reference Books:

MEP208 Design LAB-I

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

V Semester

MEL302 HEAT TRANSFER

4 credits (4-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : **:** On completion of this course, students will be

1. Understand the basic laws of heat transfer.
2. Account for the consequence of heat transfer in thermal analyses of engineering systems.
3. Obtain numerical solutions for conduction and radiation heat transfer problems.
4. Evaluate heat transfer coefficients for natural convection and forced convection.

Analyze heat exchanger performance by using the method of heat exchanger effectiveness.

Content:

Basic modes of Heat Transfer & their mechanisms : Introduction, Conduction: Fourier law of heat conduction, Thermal conductivity, General conduction equation, thermal diffusivity, One Dimensional, steady-state, without heat generation heat transfer, Concept of thermal resistance and electrical analogy, Conduction through composite slab/cylinders/spheres, Contact resistance/ Fouling Factor, Overall heat transfer coefficient, Critical thickness of Insulation, Analysis of extended surfaces: Rectangular profile longitudinal fins/ spines, Lumped heat capacitance method of unsteady analysis.

Forced Convection : Flow over flat plate, Hydrodynamic & thermal boundary layer, Prandtl Number, Nusselt Number, Reynolds Number, Local and average heat transfer coefficient, Empirical relations for external flows, Flow through ducts.

Natural Convection: Natural Convection from vertical plate, Grashoff's Number, Empirical relations for natural convection from various bodies.

Condensation: Filmwise and Dropwise condensation, Nusselt theory for filmwise condensation on vertical plates, Pool Boiling Curve.

Radiation : Laws of Radiation, Black body, Grey body &Coloured body, Emissivity, Black body radiation, Shape factor & its properties, Radiation exchange between two gray surfaces.

Heat Exchanger : Classification of heat exchangers, LMTD Approach for parallel & Counter flow heat exchangers, NTU approach for parallel/ Counter flow heat exchangers, Design aspects of heat exchangers.

Text Books/ Reference Books:

1. Incropera, F.P., Dewitt, D. P., “Funda. of Heat & Mass Transfer”, John Wiley & Sons ,4th 1996.

2. Holman, J. P., "Heat Transfer", McGraw Hill, 8th Edition, 2003 .

3. Sukhatme, S. P., "A Textbook on Heat Transfer", Orient Longman Ltd Bombay, 1985 .

4.T hombre, S.B., "A data book on Thermal Engg, Ed ", Green Brains Publication, 1st Edition, 2003 .

MEL308 ENERGY CONVERSION–II

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :On completion of this course, students will be

1. Classify various types of I.C. Engines and Cycles of operation.
2. Express the effect of various operating variables on engine performance
3. Discuss fuel metering and fuel supply systems for different types of engines
4. Distinguish normal and abnormal combustion phenomena in SI and CI engines
5. Justify the suitability of conventional and non-conventional fuels for IC engines
6. Solve the performance of Gas Turbine and Jet engines

Content:

I.C. Engines : Air standard and fuel air cycles, parts of I.C. engines, two stroke and four stroke I.C. engines, SI and CI engines, combustion in SI and CI engines, detonation, carburetion and diesel injection. Measurement of power: indicated, friction and brake power, fuel and air consumption, indicated, brake, volumetric and mechanical efficiency, percentage of excess air, heat balance sheet, performance characteristics & factors influencing the performance of I.C. engines.

Gas Turbines & Jet Propulsion : Ideal cycles, small stage efficiency, pressure losses, intercooling, reheat & regeneration, fuel-air ratio, combustion efficiency, performance calculations, open cycle and closed cycle gas turbines. Working of turbojet, turboprop, ramjet & pulsejet, performance.

Reciprocating Compressors :Parts, operations, work done during isothermal, polytropic& adiabatic compression process, PV diagram, isothermal, volumetric and mechanical efficiency, effect of clearance, multistage compressor, condition for minimum work input, capacity control, actual indicator diagram.

Refrigeration And Air Conditioning : Vapor compression refrigeration system, analysis, actual refrigerating cycle, effect of subcooling& superheating, C.O.P., performance calculation, psychometric chart and processes such as heating cooling, humidification & dehumidification.

Text Books/ Reference Books:

1. Ballaney P.L. “Thermal engineering, Ed;, ”,Khanna Publishers ,24th 2003.
2. Holman J. P.,"IC engines",McGraw Hill,2nd 2004 .
3. Arora C.P."Steam and Gas Turbines; ",Tata McGraw Hill,2nd 2001 .
4. YadavR.."Steam and Gas Turbines;"Central Publishing house Allahbad,,2001 .

MEL305MANUFACTURING PROCESSES – II

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

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

1. Explain machining processes and cutting action involved.
2. Calculate / estimate machining parameters.
3. Differentiate among various machining processes.
4. Select appropriate machining operation for particular application.

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	H	L	L	---	L	L	M	L	L	M	H

CO2	H	M	M	---	L	L	M	L	L	M	H
CO3	H	M	L	---	L	L	M	L	M	L	H
CO4	H	L	L	---	L	M	M	L	M	L	H
Overall	H	M	L	---	L	L	M	L	M	M	H

Content:

Basic machining processes and machine tools like Lathe, Shaper, Planer, Drilling, Milling, etc. Main types and parts of each machine, common operations on these machines (CO1, CO3, CO4),

Operating parameters and evaluation of parameters such as machining time, material removal rate, surface roughness, etc. (CO2)

Cutting tools and tool materials: Essential properties of tool materials, common tool materials and their usages, tool geometry. (CO1, CO2, CO4)

Finishing Processes

Grinding process and machines, basic principles, types of grinding, grinding wheels, fine finishing operations such as lapping, honing, polishing and buffing. (CO1, CO3, CO4)

Theory of Metal Cutting

Introduction, orthogonal and oblique cutting, mechanics of metal cutting, shear plane stress, strain and cutting forces, chip formation. (CO1)

Cutting force calculation, determination of torque and power requirement for various operations. Influence of tool angles, cutting fluids, cutting tool materials, cutting speed, feed and depth of cut on power requirement, tool life, etc. (CO2)

Non-conventional Machining Processes:

Introduction, classification, water jet machining, chemical machining, electro chemical machining, electrical discharge machining, etc. (CO1, CO3, CO4)

Text Books/ Reference Books:

1. Boothroyd G. and Knight W. A. “Fundamentals of Machining and Machine Tools”, Third Edition, CRC Press, Taylor and Francis, 2006.
2. Trent E. M. and Wright P. K. “Metal Cutting” Fourth Edition, Butterworth-Heinemann,

2000.
3. Ghosh A., Mallik A.K "Manufacturing Science", Affiliated East-West Press Pvt. Ltd, 2001.
4. Hajra-Choudhary S.K., Bose S.K, Hajra-Choudary A.K., Roy H. "Elements of Workshop Technology", Media Promoters & Pub, Vol. II. 2010.

MEL307 FLUID MACHINES

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :On learning this subject students will be able

1. To select a turbine or a pump etc. depending upon the availability of resources and requirement of the project in hand.
2. To calculate various parameters like efficiency, specific speed etc. To some extent the students will get expertise about the design methodologies of Fluid Machinery.

Content:

Roto dynamic machinery

Operation, performance and similarity laws of roto dynamic machineries

Pumps

Types of pumps, fans, blower, and compressors, cavitation in pump

Hydraulic design of centrifugal type pump and blower.

Hydraulic design of Positive displacement type and jet pump type machinery.

Turbines

Impulse and reaction type hydro turbines; operation, performance, similarity laws,

Hydraulic design of impulse type and radial flow type hydro turbines.

Text Books/ Reference Books:

1.Vasandani V.P. "Hydraulic Machines",Khanna Publishers,1984.

2.KumarD.S,"Fluid Mechanics and Fluid Machines; ",S.K.Kataria& Sons,4th Ed 1992 .

3.BansalR.K,"Fluid Mechanics and Fluid Machines,;, ",Laxmi Publications,7th Ed 2002.

4.LalJagdish"HydraulicMachines"Metropolitan Book Co. Ltd,,7th Ed 1984.

5.Rajput R.K. “Hydraulic Machines,; S.Chand&Co.”,Metropolitan Book Co. Ltd,,1st Ed..

6.Church A.H., LalJ"Centrifugal Pumps and blowers",Metropolitan Book,6th Ed 1973 .

7.MasseyB.S"Turbines, Fans and Compressors;, ",Van Nostrand Reinhold Co.,6th Ed 1989.

8.YahyaS.M."Turbines, Fans and Compressors;"Tata McGraw Hill,,1999.

MEP307FLUID MACHINES
1 credits (0-0-2)
Pre-requisites: NIL
Overlaps with:

Course Outcomes/ Objectives :

On completion of this course, students will be

1. Design piping system and its components.
2. Evaluate and compare different flow meters.
3. Predict losses in various fluid dynamical systems.
4. Explain the role of pressure as a driving force.
5. Calibration of flow meters.

Content:

1. Determination of viscosity of a fluid by falling sphere method
2. Study of manometers
3. Study of pressure variation along the depth in an incompressible fluid
4. Study of vortex motion
5. Determination of metacentric height of a ship model
6. Tracing of stream lines
7. Verification of Bernoulli’s equation
8. Determination of drag and lift coefficients
9. Determination of coefficient of discharge of a venturi/ orifice meter
10. Determination of coefficient of discharge of an orifice/ mouthpiece
11. Determination of coefficient of discharge of different notches
12. Study of Hagen Poiseuille flow
13. Reynolds experiment

Other experiments based on the theory syllabus

Text Books/ Reference Books:

MEP305 MANUFACTURING PROCESSES II

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : Students will be able to –

1. Understand basic machining operations like turning, drilling, shaping, etc.
2. Work on machine tools to perform basic machining operations
3. Select appropriate machining parameters for selected work piece and tool
4. Get exposure to workshop environment

Experiment based on syllabus of Manufacturing Processes – II

Mapping with POs:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	H	L	L	---	---	L	L	L	M	M	M
CO2	H	L	L	---	---	H	L	L	M	M	M
CO3	H	L	M	---	---	M	M	L	M	M	M
CO4	L	L	M	---	---	H	M	M	M	M	M
Overall	H	L	M	---	---	H	M	L	M	M	M

Content:

Perform specified machining operations on Lathe, Shaping, Drilling and Milling machines.

(CO1, CO2, CO3, CO4)

Text Books/ Reference Books: NA

MEL313 MACHINE DRAWING

2 credits (2-0-0)

Pre-requisites: NIL

Overlaps with:

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

1. Understand and apply the knowledge of machine drawing as a system of Communication in which ideas are expressed clearly and all information fully conveyed.
2. To understand principals and conventions of Machine Drawings as per BIS.
3. To understand the geometry and proportions of standard machine components.
4. To understand various symbols used in drawing to define precise and total requirement.
5. To understand assembly principles and hence required fits and tolerances.
6. To understand geometrical specifications and process of manufacturing based on all requirements of a component belonging to an assembly in the form of Production Drawing.
7. To understand and prepare assembly drawings.

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	H	H	H	-	-	L	H	-	H	M	H
CO2	H	H	H	-	-	L	H	-	H	M	H
CO3	H	H	H	-	-	L	H	-	H	M	H
CO4	H	H	H	-	-	L	H	-	H	M	H
CO5	H	H	H	-	-	L	H	-	H	M	H
CO6	H	H	H	-	-	L	H	-	H	M	H
CO7	H	H	H	-	-	L	H	-	H	M	H
Overall	H	H	H	-	-	L	H	-	H	M	H

Content:

Drawing Standards for following:

Drawing Sheets, Name Blocks, Lines, Sections, Dimensioning, Dimensioning of Tolerances Standard Components, Standard Features, Machining Symbols, Welding Symbols, Surface Finish Symbols, Heat Treatment, Manufacturing Instructions, Allowances, Materials.

Orthographic Projections of Elements

Orthographic Projections, Sectional Views, Multiple Views, Missing Views, Profiles, Cross sections, References, Alignments, Dimensioning. CO1 & CO2

Study, qualitative selection of type / size (excluding design calculations) and standard practices for the following elements

Threads, Bolts, Nuts, Washers, Rivets, Welds, Keys & Keyways, Splines, Couplings.

----- CO3 & CO4

Assembly and Dismantling Techniques, Principles of Assembly:

Fits and Tolerances (Standard, types, application and selection) Tolerance Charting Surface Finish requirement for assembly, Manufacturing Method, Geometrics suitable for assembly, Assembly/Dismantling Tools, Bearing Assemblies, Assemblies by fastening. – CO5 & CO6

Assembly Drawings (Principles, techniques and standards of drawing of following)

Component, Subassembly, Full assembly, Exploded Views, Various frames / brackets / housings / casings, Study of some standard assemblies.

Production Drawing:

Name Plates, Part List, Revisions, etc., Essential Parts/Formats required for production drawing, Process Sheet --- CO7

Text Books/ Reference Books:

1. Naryana K.L., Kannaiah R., Venkata Reddy K “Machine Drawing”, New Age Int.Pub.

2. Naryana K.L., Kannaiah R., Venkata Reddy K “Production Drawing ", New Age Int.Pub.

3. N.D.Bhatt “Machine Drawing; Ed”, Charotar Publishing House.

4. PSG College of Technology “Design data”, DPV Printers, Coimbature.

5. “Engg. Drawing practice for schools & colleges”, Bureau of Indian Standards, 1st1998.

All latest editions as and when available.

MEP313 MACHINE DRAWING

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

1. Students will be capable of making pencil drawings for components and assembly.
2. Students will be capable of reading drawings.
3. Students will be capable of preparing production drawing and process planning for a component.
4. Students shall be acquainted with computer graphics.

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	H	H	H	-	-	L	H	-	H	-	H
CO2	H	H	H	-	-	L	H	-	H	-	H
CO3	H	H	H	-	-	L	H	-	H	-	H
CO4	-	-	-	-	-	-	M	-	-	H	-
Overall	H	H	H	-	-	L	H	-	H	M	H

Content:

1. Pencil drawings of Orthographic Projections: 2 Sheets (A1 size)
2. Pencil drawings of Standard Components: 4 Sheets (A1 size)
3. Pencil drawings of Assembly: 2 Sheets (A1 size) --- CO1
4. Production Drawing of components of assembly (Pencil): 2 Sheets (A1 size)
5. Process planning for components: 1 Sheet (A1 size) --- CO3
6. Reading of a Machine Drawing. --- CO2
7. One assembly and its components using computer graphics: 1 Sheet (A1 size) --- C04

If A2 size sheet is used in place of A1 then number will be doubled and if A3 size is used then it will be quadrupled.

Text Books/ Reference Books:

MEP302 THERMAL

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : **:** On completion of this course, students will be

1. Ability to measure the thermal conductivity of different common metallic materials.

2. Ability to measure the quantity of heat transfer between fluids and solid boundaries.

3. Ability to measure the amount of heat exchanged between fluids flowing within heat exchangers

4. Ability to carry out simple experimental work in irradiative heat transfer

Content:

1) Thermal conductivity of insulating powder. To compare theoretical & practically observed temperature distribution (pin fin) experiment in a pin fin when subjected to forced and convection.
2) To compare performance of HX in parallel & counter flow mode.
3) To determine heat transfer coefficient over a cylindrical body under transient conditions.

4) To determine thermal efficiency of solar collector under natural and forced convection of operation.
5) To determine thermal conductivity of metal rods.
6) To determine heat transfer coefficient under filmwise / dropwise condensation.
7) To observe the different boiling regimes on a cylindrical rod.
8) To determine critical heat flux
9) To determine htc for flow through pipes
10) To determine htc for flow through pipes forced convection from a vertical / horizontal / inclined plates.

Text Books/ Reference Books:

MEL416INDUSTRIAL ROBOTICS

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : On completion of this course, students will be

1. Analyze the manipulator design including actuator, drive and sensor issue
2. Calculate the forward kinematics, inverse kinematics and Jacobian for serial and parallel robots
3. Identify different types of end effectors and sensors required for specific applications
4. Develop programming principles and languages for a robot control system
5. Discuss various applications of industrial robot systems.

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	H	M	H	L	M	-	-	-	-	M	-
CO2	H	-	M	L	H	-	-	-	-	H	-

CO3	H	H	H	H	H	-	-	-	L	M	-
CO4	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	L	L	H	-
Overall	H	M	H	M	H	-	-	L	L	M	-

Content:

Introduction: Construction of manipulators, advantages and disadvantages of various kinematic structures. (CO1) (CO5)

Actuators: Pneumatic, hydraulic and electric. Characteristics and control. Nonservo robots, motion planning. Feed back systems, encoders, servo control PTP and CP. (CO1)

Introduction to Kinematics:

Homogeneous coordinates, solution of the inverse kinematics problem, multiple solutions, jacobian, work envelopes. (CO2)

Trajectory planning

Manipulator dynamics and force control. (CO3)

Sensors

Vision, ranging, laser, acoustic, tactile. Developments in sensor technology, sensory control.

Programming Language: VAL, RAIL, AML. Mobile robots, walking devices. Robot reasoning and Robot applications(CO4)

Text Books/ Reference Books:

1.FuK.S, Gonzalez R.C., Lee C.S.G., "Fundamental of Robotics", McGraw Hill, 1987.
2.Koren Y., "Robotics for Engineers", McGraw Hil, 1985 .
3.CraigJ.J,"Robotics", Addison Wesley, 1986.

MEL421 COMPUTATIONAL METHODS IN ENGINEERING

3 credits (3-0-0)

Pre-requisites: Engineering Mathematics

Overlaps with: No

Course Outcomes/ Objectives : On completion of this course, students will be

1. Able to demonstrate an ability to identify, formulate, analyze and solve mechanical engineering problems numerically under realistic constraints.
2. Trained with computer programming language such as MATLAB and Excel softwares.
3. Trained for solving real life problems as well as for higher studies and research.

Mapping with POs:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	H	H	H	M	H	L	H	H	L	L	H
CO2	H	L	M	M	H	M	M	L	L	H	M
CO3	M	M	M	H	H	M	M	M	L	H	L
Overall	H	M	M	M	H	L	L	L	L	H	M

Content

Boundary value problems. Type of boundary condition: Neumann and Dirichlet boundary condition. Finite difference method using central difference formula, Solution of 1D and 2D stress analysis and heat transfer equations. Variational methods for stress analysis and vibration problems. Rayleigh Ritz method. Extension of variational methods to heat transfer problems. Weighted residual methods. Collocation and Galerkin method. Introduction to Finite element method.[1,2,3]

Numerical methods for computing roots of equations. Newton-Raphson's, Bisection, Regula-falsi, and Secant method. Rate of convergence: Solution for system of linear equations Gauss Jacobian, Gauss-Elimination, Gauss-Jordan, LU decomposition, Choleski decomposition method. Iterative methods of Gauss-Seidal and Gauss Jordan. Nonlinear equations and their solution by Newton Rapson method. Eigenvalue problems. Eigen value by direct and power method, Sweeping matrix and mode orthogonality principle. [1,2,3]

Interpolation and curve fitting: Lagrange interpolation. Newton divided difference interpolation, Newton forward and backward difference interpolation, Spline interpolation: cubic spline and Bezier curves. [1,2,3]

Numerical integration method: Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Gauss Legendre Quadrature. Numerical solution of ODE(IVP) using Euler, Predictor-corrector, mid- point, Runge-Kutta 2nd , Runge-Kutta 4th order method .Numerical solution of ODE(BVP) using finite difference method and central difference method. [1,2,3]

Text Books/ Reference Books:

1. Kreyszig, E. Advanced Engineering Mathematics, John Wiley & Sons, 7th Edition, 1993.
2. J Ramachandran, Boundary and Finite Elements, Narosa Publications
3. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI
4. Grerald and Wheatley, Applied Numerical Analysis, Pearson publication
5. BhaskarDasgupta, Applied mathematical Methods, Pearson publications

VI Semester

MEL311 Metrology & Quality Assurance

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :On completion of this course, students will be

1. Able understand the standards, concepts and terminology of mechanical metrology.
2. Learn the principles of linear and angular measurements and instrumentation.
3. Able to understand and analyze the production drawings for dimensional and geometrical tolerances and the concepts of Surface roughness and machine tool metrology.
4. Able to apply the statistical quality control concepts and control charts for manufacturing.

Mapping with POs*:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	M	L	-	M	-	-	-	H	H	-	M
CO2	H	H	H	M	-	-	-	M	H	H	H
CO3	H	H	M	-	-	-	-	H	M	-	H
CO4	H	M	M	-	H	-	-	M	M	M	H
Overall	H	M	M	M	L	-	-	H	H	M	H

Content:

Metrology Measurements, Errors, Standards, Various precision measuring instruments, Straightness, Flatness, Squareness, Roundness measurement, Angular measurement. Principles of Comparators. CO1 & CO2

Calibration of all measuring instruments. Principles of gauge design - Types of gauges, Taylor's principle of gauge design, Limits, Fits, Tolerances. CO3

Interferometer - Principles, Sources of light, Optical flat, Fringe patterns, Calibration of optical

flat and It's applications, Tool maker's microscope, Profile projector. CO2

Surface finish measurement - Surface texture terminology measurements of surface roughness and instruments. Machine tool metrology - Alignment test, Performance test of Lathe, Milling and Drilling machine. Metrology of screw thread - Screw thread terminology, Thread gauges. CO3

Statistical quality control - Basic statistics, Mean, Mode, Standard deviation, Frequency distribution, Control chart for variables, Attributes, Process capability. Acceptance sampling - Sampling inspection, Operational characteristics curve, Consumer's risk, Producer's risk, AQL, LTPD, AOQL. Quality standards - ISO 9000 : 2001, TS 16949 (Standard, FMECA (Failure mode effect criticality analysis) FTA (Fault tree analysis). CO4

Text Books/ Reference Books:

1. Gupta, I. C., "Engineering Metrology", DhanpatRai, 2000
2. Jain, R. K., "Engineering Metrology", Khanna Publisher, 20th Edition 2013
3. M. Mahajan, Statistical Quality Control, DhanpatRaiPublisher, 2012

MEL312 MECHANICAL MEASUREMENTS

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :On completion of this course, students will be

1. Capable of identifying basic elements in the measuring system.
2. Possessing the knowledge of various measuring devices and their characteristics.
3. Capable of selecting appropriate measuring device based on measuring requirements vis a vis characteristics of measuring devices and their range of operations.
4. Capable of understanding how a raw signal from a sensor is processed for display or control.

Mapping with POs:

POs	a	b	c	d	e	f	g	h	i	j	k

→ COs ↓											
CO1	H	H	H	M	L	-	H	L	H	L	H
CO2	H	H	H	M	L	-	H	L	H	L	H
CO3	H	H	H	M	L	-	H	L	H	L	H
CO4	H	H	H	M	L	-	H	L	H	L	H
Overall	H	H	H	M	L	-	H	L	H	L	H

Content:

General Principles, purpose and performance of measurement systems, Structure and Examples of measurement systems, Block diagram. ---- CO1

Systematic characteristics, Statistical characteristics, Identification of static characteristics – calibration. Basics of dynamic characteristics.

Measurement error of a system of ideal elements, the error probability density function of a system of non-ideal elements, Error reduction techniques, ---- C02

Elements of Measurement Systems: Classification, Principle, Construction, Range and working of following instruments (Analytical Treatment Not included). Displacement, force, speed, torque, flow, level, pressure, sound and light ---- C03

Signal Processing: Sensing elements, Types of Signals, Signal Processing and Conditioning elements, Data Acquisition, Digital Techniques in Mechanical Measurements, Readouts and Data Processing, analysis and Data Presentation elements. ---- C04

Text Books/ Reference Books:

1. Bentley, John P. , “Principles of Measurement Systems”, Pearson Education Limited
2. NakaraChoudhari, “ Instrumentation Measurement and Analysis,” TMH Publications
3. Doeblin O.E, “Measurement Systems”, McGraw Hill Publications
4. Beckwith T G, Buck N L, Marangoni R D “Mechanical Measurement”, Addison Wesley Pub. Co.

MEP314MECHANICAL MEASUREMENTS AND METROLOGY
1 credits (0-0-2)

Pre-requisites: NIL
Overlaps with: NIL
Course Outcomes/ Objectives :

1. Be able to apply knowledge of basic scientific and engineering principles in getting solutions to mechanical measurement related problems.
2. Be able to design and conduct experiments as well as analyze and interpret data.
3. Be able to design a system or a component of a system for a specific task related to Mechanical Measurement.
4. Be able to understand multi-disciplinary task related to Mechanical Measurement.

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	H	L	L	L	-	-	-	-	-	-	-
CO2	H	H	H	H	-	-	-	-	-	-	-
CO3	L	L	L	L	-	-	-	-	-	-	-
CO4	L	H	H	H	-	-	-	-	-	-	-
Overall	H	H	H	H	-	-	-	-	-	-	-

Content:

1. Calibration of Vernier / Micrometer / Dial Gauge
2. Checking Dimensions of part using slip gauges
3. Measurements of Gear Tooth Dimensions
4. Measurement of Angle using sine bar / sine center / tool makers microscope
5. Measurement of straightness and flatness
6. Measurement of thread parameters
7. Setting up of comparators for inspection (Mechanical / Pneumatic / Electrical)

8. Measurement of Temperature using Thermocouple / Pyrometer
9. Measurement of Displacement
10. Measurement of Force
11. Measurement of Torque
12. Measurement of Vibration
13. Measurement of SPL and light intensity

Text Books/ Reference Books:

MEL309 MACHINE DESIGN –II

4 credits (3-1-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : On completion of this course, students will be

1. Able to design components of mechanical systems.
2. Capable of designing Mechanical Components and assemblies for industrial & domestic applications.
3. Able to carry out research on advanced machine design.
4. Capable of modifying the existing systems and developing better components

Mapping with POs:

CO/ PO	a	b	c	d	e	f	g	h	i	j	k
CO1	H	L	L	H	H	H	M	-	H	H	M
CO2	M	H	H	-	H	-	-	M	-	-	H
CO3	H	M	H	H	M	M	H	H		M	H
CO4	L	L	M	M	-	H	-	-	-	M	-
Overall	M	M	M	H	H	H	M	M	H	M	H

Content:

Unit I. Bearings and Design for rotating bodies :Surface finish, frictions wear, lubrication, oil seals, design of journal bearings for radial and thrust loads, selection of ball and roller bearing for radial and thrust loads. Failures of antifriction bearing, design of hydrostatic pocket type

thrust bearing such as circular step thrust bearing, bearing housing.

Unit II. Coupling :Types of shaft coupling, design of flange coupling, flexible bush coupling. Flywheel: Coefficient of fluctuation of energy and Coefficient of fluctuation of speed, energy store in flywheel, stresses in flywheel, design of flywheel.

Unit III. Friction and chain drive :Types of belts & belt material, analysis of belt tension, condition for transmitting maximum power, design of flat belt, flat belt pulley. V belt drive: Types of V-belt, analysis of V-belt tension, design of V belt pulley, Roller change drive: Velocity ratio and length of chain, design of chain, dimensions of tooth profile, sprocket.

Unit IV. Spur, Helical and Bevel Gear :Review of Kinematics of gears & terminology, interference, tooth profiles, formative number of teeth etc. Buckingham equation, design of spur gear drive, helical gear drive. Bevel gear drive: Types of bevel gear proportions of bevel gear, force analysis of bevel gear drive design of bevel gear drive.

Unit V. Worm Gear and Hoisting Systems :Worm gear drive: Types and proportion of worm and worm gear, force analysis, beam strength of worm gear teeth, dynamic tooth load, wear load, thermal rating of worm gear, design of worm and worm gear. Introduction to haulage system, design of wire rope, sheave and drums, Electric motor rating, types of motor like AC, DC, their Characteristics, controls, selection motors.

Text Books/ Reference Books:

1. Maleev V.L., Hartman J.B, "Mechanical Design of Machine", CBS Pub. & Distributors, 1983
2. Black P.H., Adams O.E, " Machine Design", McGraw Hill,1968
3. Shigley J.E, " Mechanical Engineering Design", McGraw Hill International, 1986

MEL310MANUFACTURING PROCESS AUTOMATION

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :On completion of this course, students will be

1. Demonstrate a thorough understanding of the principles and theoretical bases of modern manufacturing techniques, automation, and production processes.
2. Identify appropriate manufacturing systems for different production requirements, and

describe their performance using appropriate analytical and modeling methods.

3. Apply appropriate technology, quality tools and manufacturing methodology to design, re-design and continuously improve the manufacturing operations of engineering companies.

Mapping with POs:

POs → / COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	H	H	L	-	H	H	H	M	H	L	L
CO2	L	L	-	M	H	-	-	-	-	L	M
CO3	L	M	-	H	H	-	L	-	-	L	-
Overall	M	M	L	M	H	L	M	L	L	L	L

Content:

Gear Manufacturing :Gear casting gear milling, gear shaping, gear bobbing for spur helical and bevel gear. Tooling and selection of cutting parameters, Process accuracy and quality of gears. Gear stamping. Process, gear drawing. Processes, Rolling process, gear finishing gear shaving, gear lapping, gear honing. Processing of plastics: Plastic molding methods, thermoforming, coding, laminate forming, machining of plastic, reinforced plastics. (CO1)

Press working : Die cutting operation, classification, types of presses, press terminology, introduction to shaping operations, bending forming & drawing, Introduction of Jigs and Fixtures : Difference between jigs and fixtures, uses, principles of jigs and fixture design. Materials, principles of location, methods of location, Clamping requirements, types of clamps, jig bushes, drilling jigs, milling fixtures, classification of fixtures. (CO2)

Automated Machines :NC, Basic components, co-ordinate system, types, NC part programming, DNC, types, advantages, limitations, CNC, AC, CIM, FMS. Robotics: Robot anatomy, configurations, types of control, accuracy & repeatability of robot, end effectors, sensors, robot programming, robot applications. Automated material handling and Inspection :Types of automation, reasons for automation, automated guided vehicle, types, applications, traffic control and safety. ASRS, types, basic components, applications, carousel storage system. CAQC,

CAPP, G.T. (CO3)

Text Books/ Reference Books:

1. Sharma P.C, “Production Technology”, S. Chand & Co. Ltd, 10th Ed 2003
2. Groover, M. P., “ Automation production systems and CIMS”, Prentice Hall of India, 9th Ed 2002
3. KorenYoram, “Computer Control of Manufacturing Systems”, McGraw Hill, 3rd Ed, 1986

MEP310MANUFACTURING PROCESS AUTOMATION

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : On completion of this course, graduate student will be able to do

1. Part programming for CNC machine
2. Design of Jigs and fixtures for the given part
3. Use of automation software, robots for industrial application

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	-	H	H	-	-	-	-	M	-	H	H
CO2	-	M	M	-	-	-	-	M	-	-	M
CO3	-	M	M	-	-	-	-	M	-	M	M
Overall	-	M	M	-	-	-	-	M	-	M	M

Content:

1. Performance, Simulation on CNC lathe (at least two Complex Geometries)
2. Performance, Simulation on CNC milling (at least two Complex Geometries)
3. Case Study on FMS design for an industry
4. IRB120 and SCORBOT ER-4U robot programming
5. Designing a Jig and Fixture for the given part

6. Part Coding and Group Technology
7. Simulation using Automation studio software

Text Books/ Reference Books:

MEP309 MACHINE DESIGN II

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : After the completion of this lab course student will be

1. Able to understand the importance of design of machine
2. Capable of designing mechanical components with minimum errors and flaws
3. Able to appreciate the function and performance of mechanical systems
4. Able to perform the characterization of different parts of machine.

Content:

1. Measurement of Backlash error using Gear Rolling Tester
2. Measurement of Misalignment using Shaft Alignment Kit
3. Tensile testing of Mild steel specimen in Universal Testing Machine
4. Tensile testing of standard Aluminum sample on Universal Testing Machine
5. Fatigue testing of standard specimen on Servo Hydraulic Universal Testing Machine
6. Non Destructive Testing using Magnetic Particle testing Kit
7. Study of characteristic of Journal Bearing Test rig
8. Study of Plane ad Circular Polaris cope
9. Study and demonstration of Isoclinic and Isochromatic fringes
10. Measurement of Fringe value of Birefringent material using Photo elasticity setup

Text Books/ Reference Books:

MEL432COMPUTER GRAPHICS AND SOLID MODELING

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

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

1. Understand and manipulate coordinate systems, views, and transformations
2. Describe a use the main curve representations and determine their differential properties
3. Describe a use the main surface representations and determine their differential properties
4. Construct sketches and place geometric and topologic constraints on them

Mapping with POs:

CO/ PO	a	b	c	d	e	f	g	h	i	j	k
CO1	L	L	H	H	H	M	L	H	--	M	-
CO2	H	H	-	-	-	H	M	L	--	-	M
CO3	M	H	H	H	M	H	--	--	L	H	H
CO4	L	M	M	-	M	-	--	M	L	-	-
Overall	M	M	H	H	M	H	L	M	L	M	M

Content:

Unit I. Introduction to Computer Graphics, Application of Graphics, Graphic devices, display systems, refresh CRT, Raster scan and random scan, color monitors, VGA, flat panel display, LED and LCD, input and output devices.

Unit II. Graphical User Interface, Introduction, Types of GUI, widgets, components, Design of GUI, User centered design, Event driven programming, Principles of good GUI design. Windows and clipping, windows and Viewport, clipping, point clipping, line clipping, Sutherland cohen subdivision line clipping algorithm, Midpoint subdivision algorithm.

Unit III. Scan conversion and output primitives, DDA algorithm, Bresenham line drawing algorithm, Bresenhem's midpoint circle and ellipse algorithm, polygon filling.

Unit IV. 2D and 3D transformations, geometric transformation using homogenous matrix method, translation, rotation, scaling, reflection, and shearing. Successive transformation and composite transformation.

Unit V. Solid Modeling vs. surface modeling, Types of representation, spatial enumeration, cell decomposition, boundary representation, sweep representation, primitive instancing, constructive solid geometry, Advanced modeling techniques, procedural modeling, Multi-particle rendering, Volume rendering, Grammar based system.

Unit VI. Curves, curves representation, parametric and non parametric form, properties of curve representation, interpolation and approximation, Blending functions, 3d Space curves, Spline, cubic Spline, B-spline, Bezier curves, properties of Bezier curves, Hermite curves, comparison of curves, 3D surfaces, Super-quadric surfaces, blobby objects.

Text Books/ Reference Books:

1. Edward Angel, "Interactive Computer Graphics"
2. Hearn and Baker, "Computer Graphics C version "
3. ISRD Group, "Computer Graphics", McGraw Hill Companies

MEP432 COMPUTER GRAPHICS AND SOLID MODELING

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

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

1. Model any complex component using Solid Modeling Technique
2. Transform in 2d plane and 3D space any object without distorting.
3. Create complex assemblies from basic parts and simulate it.
4. Perform basic static analysis on the assemblies.

Content:

1. Demonstration of different tools and commands.
2. Creating different sketches on 2D plane and performing transformations on it
3. Use of commands like, protrusion, extrusion, cut, draft, and other solid modeling commands
4. Use of Surface commands like, blue surf, project curve, blend etc
5. Use of Boolean operation like, union, subtraction and intersection
6. Conversion of surface and hollow objects to solid objects using command like stitch

or thicken

7. Creation of different part copy files for assembly environment
8. Use of commands from Assembly environment
9. Use of different type of constraints
10. Simulation and Animation of assemblies.

Text Books/ Reference Books:

MEL442COMPUTER & DATABASE MANAGEMENT
3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

MEP442COMPUTER & DATABASE MANAGEMENT
1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

MEL422 AUTOMOBILE ENGINEERING

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : On completion of this course, students will be

1. Able to understand various systems in vehicle
2. Gain knowledge regarding maintenance and testing of vehicle.

Content:

Introduction: Automobile history and development Present scenario of automobiles in India and Abroad. Chassis, articulated and rigid vehicles and vehicles layout. Prime movers. I. C. Engines, Gas turbines, Wankel engine, Engine construction - Structural components and materials Review of fuel, cooling and lubrication systems Filters, water pumps, radiators, Thermostats, ant freezing Compounds. Steering & Suspension Systems: Steering systems, principle of steering, center point steering, Steering linkages, steering geometry and wheel alignment, power Steering, special steering systems. Tyres, tyres specification, factors affecting tyre performance, Special tyres, wheel balancing, suspension system- Function of Spring and shock absorber, conventional and Independent suspension System, Telescopic shock absorber, linked suspension systems,

Transmission Systems :Clutch - Necessity, requirements of a clutch system. Types of Clutches, size of clutch, centrifugal clutch, wet clutch, fluid Clutch. Transmission, Necessity of transmission, principle, types of transmission, Sliding mesh, constant mesh, synchromesh, Transfer gear box, Gear Selector mechanism, lubrication and control. Overdrive, Torque Converter, Automatic Transmission.

Propeller shaft, Universal joint, constant velocity joint, Hotchkiss drive, and torque tube drive. Differential - Need and types Rear Axles and Front Axles. Brakes: Need, types Mechanical, hydraulic, Pneumatic brakes, Electrical Brakes, Engine Exhaust brakes, Drum and Disc brakes, Comparison. Details of components, Brake adjustment. Electrical systems: Construction. Operation and maintenance of Lead acid batteries, battery charging system, Principles and Operation of cutout and regulators, Starter motor, Battery Ignition and magneto ignition systems ignition timing. Lighting and electrical accessories Automobile air- conditioning, Panel board

instruments.

Maintenance & Testing: Maintenance, Trouble shooting and service, procedures, Overhauling, Engine tune up, Tools and equipment for repair and Overhaul. Testing equipments. Inspection, laboratory and road testing of automobiles. Safety Considerations in automobiles, Tractors, Trailers, Fun mobiles, Hybrid vehicles racing cars. Recent Advances in automobiles such as ABS, Electronic Power Steering, and Steer by wire, Traction control, Active suspension, Collision avoidance, Intelligent lighting, Navigational aids and Intelligent vehicle highway system.

Text Books/ Reference Books:

1. Singh, K., "Automobile Engineering-Vol. Vol. II", Standard pub. & Distributors, 9th Ed 2003
2. Ramalingum K.K, "Automobile Engineering", Scitech Publications, 2001
3. Srinivasan S., "Automotive Engines", Tata McGraw Hill, 1985
4. Crouse W.H, "Automotive Mechanics", Tata McGraw Hill, 2002

MEP422 AUTOMOBILE ENGINEERING
1 credits (0-0-2)

Pre-requisites: NIL
Overlaps with:
Course Outcomes/ Objectives :

Content:

List of experiments

1. Study of Carburetors
2. Study of Fuel Injection Systems
3. Study of Engine Components
4. Performance Characteristics of C.I. Engine
5. Performance Characteristics of C.I. Engine
6. Experiment on Air Pollution

Text Books/ Reference Books:

MEL429 Renewal Energy Sources

3 credits (3-0-0)

Pre-requisites: Heat Transfer

Overlaps with: Solar Energy Utilization

Course Outcomes/ Objectives :

After completion of this course, student will be able to

1. learn the fundamentals of geometry of solar radiation and its relation to renewal sources of energy

2. analyze the performance various solar thermal systems and photovoltaic(PV) systems

3. model various renewal energy of sources

Mapping with POs:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	H	H	H	H	H	H	H	M	H	L	L
CO2	L	L	M	M	H	M	H	L	L	L	M
CO3	L	M	L	H	H	L	L	M	M	L	-
Overall	M	M	L	M	H	L	M	L	L	L	L

Content:

Geometry of solar radiation [1]

Solar Thermal systems such as liquid flat plate collector, air heater and concentrating collector, Solar pond, Solar distillation, Solar drying. Thermal storage. Modelling of above systems, Steady state and

transient analysis, simulation in process design. [1,2]

Design and performance analysis of PV systems [1,2]

Different sources of renewal energy: Need for alternative sources of energy, various options available, principles of energy conversion using solar energy, wind energy, Ocean energy, Geothermal energy and MHD power generation [1,3]

Text Books/ Reference Books:

1. Sukhatme S.P , "Solar energy," Tata McGraw Hill, 2nd Ed 2003
2. Duffie, Beckman, "Solar energy", John Wiley & Sons, 1974
3. Parulekar B.B., Rao S, "Energy technology", Khanna Publishers, 3rd Ed 1995

MEL415 MECHANICAL VIBRATION

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :On completion of this course, students will have

1. Appreciation for the need and importance of vibration analysis in mechanical design of machine parts that operate in vibratory conditions
2. Ability to analyze the mathematical model of a linear vibratory system to determine its response
3. Ability to obtain linear mathematical models of real life engineering systems
4. Ability to use Lagrange's equations for linear and nonlinear vibratory systems
5. Ability to determine vibratory responses of SDOF and MDOF systems to harmonic, periodic and non-periodic excitation
6. General notion on frequency and time response of vibratory systems

Content:

Introduction to vibration in mechanical and structural systems. Discrete system modeling. Hamilton's principle and Lagrange's equation. Free and forced vibration response of single degree of freedom system with and without damping under harmonic excitation. Discussion on

various types of damping; viscous, coulomb, hysteretic etc. Forced response under periodic excitation and transient response through Du-hamel's integral.

Concept of response spectrum. Rotor whirling and critical speed. Vibration isolation and transmissibility ratio. Vibration isolation in automobiles. Dynamic vibration absorber. Torsional vibration in rotors. Numerical simulation using Bond graph modeling and in Simulink of Matlab.

Modeling of multi degree of freedom systems. Determination of natural frequencies using matrix iteration and deflation technique. Concept of mode shapes and orthogonality principle. Rayleigh's quotient. Free and forced response through modal analysis. Vibration of continuous systems. Longitudinal vibration of rods, transverse vibration of beams and torsional vibration of shafts.

Determination of natural frequencies and mode shapes under various boundary conditions. Introduction to FEM modeling of continuous systems. Free and forced response through modal analysis. Introduction and distinguishing characteristics of nonlinear vibration. Phase plane, equilibrium points and limit cycles.

Random vibration, correlation and spectral density functions. Vibration measurement parameters and procedures. Vibration transducers and instruments. Source of vibration in Machineries. Role of vibration measurement and analysis in machine design and machine condition monitoring.

Text Books/ Reference Books:

1. Rao, Gupta, "Theory & practice of Mechanical vibration," 3rd Edition, New Age Publication.
2. Thomson, "Theory of Vibration," 3rd Ed , CBS publication
3. Meirovitch, " Elements of Vibration analysis", 2nd Ed, McGraw Hill
4. Timoshenko, "Vibration Problems in Engineering," 5th Ed, John Willey & Sons
5. S. S. Rao , "Mechanical Vibration", Fourth Edition, Pearson Education

MEP452MACHINE SYSTEM DESIGN

3 credits (0-1-4)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : Upon completing this course,

1. Students shall be able to identify design specifications of machine.
2. Students shall be able to synthesis and design mechanism for machine.
3. Students shall be able to design power transmission system required for machine.
4. Student shall be in a position to determine forces acting on machine component. (Identifying minimum cross-section is outcome other design courses)
5. Students shall be able to design assemblies and prepare production drawings based on assemblies.

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	H	H	H	L	-	L	H	H	H	L	-
CO2	H	H	H	L	-	L	H	H	H	L	-
CO3	H	H	H	L	-	L	H	H	H	L	-
CO4	H	H	H	L	-	L	H	H	H	L	-
CO5	H	H	H	L	-	L	H	H	H	L	-
Overall	H	H	H	L	-	L	H	H	H	L	-

Content:

Design of a complete small machine or a section of a large machine. Components shall be designed taking into account manufacturing considerations. Computer based design tools should used for design, assembly and drawings. The report should consist of all key calculations including power and design of key components. Following drawings should be submitted. (One exercise shall cover all COs.)

Assembly Drawing

Subassembly drawings

Production drawings of all components which need to be manufactured.

Specifications of all standard components used.

Bill of material.

Text Books/ Reference Books:

1. Design Data; PSG College, Coimbtore, KalaikathirAchchagamCoimbtore, 2012

MEL315INTRODUCTION TO AEROSPACE ENGINEERING
3 credits (3-0-0)

Pre-requisites: NIL
Overlaps with:
Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

MEL* Design of Fixtures in Manufacturing**

3 credits (3-0-0)

Pre-requisites: Nil
Overlaps with: MEL310

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

- To understand the importance of precision manufacturing and tool design.
- To understand the principles and design techniques of jigs and fixtures.
- To design and develop jigs and fixtures for a particular part.
- To select the suitable materials for the jigs and fixture elements.

CO/ PO	a	b	c	d	e	f	g	h	i	j	k
CO1	L	L	M	-	-	-	M	-	L	M	L
CO2	M	M	H	-	-	-	M	-	-	M	H
CO3	H	H	H	M	M	H	M	-	M	H	M
CO4	H	L	M	L	-	-	L	-	M	M	M
Overall	H	M	H	L	L	M	M	-	M	H	M

Content:

Precision Manufacturing: Part Accuracy, Geometric Dimensioning and Tolerancing (GD&T), Static Stiffness & Accuracy, Supporting Elements for Work Setting, Concept of Tool Design, Overview of Tool Design. CO1

Introduction to Jigs & Fixtures: Elements and their Function, Classification and Types of Jigs & Fixtures, Fundamental Principles of Jigs & Fixtures, Features: Locating/Datum Surface, Loading/Unloading and Clamping, Tolerancing on Fixtures. CO2

Supporting, Locating and Clamping Principles: Referencing, Basic Rules for Locating, Fool Proofing, Planes of Movement and Restriction, Stability of Work, Locating Principles and Types, Locating from an External Profile, Rules of Clamping, Cutting and Clamping Forces, Types of Clamps, Non-mechanical Clamping, Clamping Accessories. CO1, CO2

Design of Jigs & Fixtures: Design Economics, Tool Design Parameters, Developing the Initial Design, Initial Drawing and Dimensioning, Limits and Critical Dimensions, Design of Milling Fixtures, Turning and Welding Fixtures, Sheet Metal Forming Fixtures, Case Studies. CO2, CO3

Materials for Jigs & Fixture Elements: Basic Properties Required for Jigs & Fixtures, Ferrous, Non-ferrous and Non-metallic Tool Materials, Designing with Relation to Heat Treatment,

Dimensional Stability. Safety and Maintenance. CO3, CO4

Text Books/ Reference Books:

1. Jig & Fixture Design, by Edward Hoffman
2. Metal Cutting and Design of Cutting Tools and Jigs & Fixtures, by N.K. Mehta
3. Jigs and Fixtures, by P. H. Joshi
4. Jigs and Fixtures: Non-standard Clamping Devices, by Hiram E Grant
5. Tool Design, by Cyril Donaldson

MEL* DYNAMICS OF MECHANICAL SYSTEM**

3 credits (3-0-0)

Pre-requisites: MEL301 Theory of Machine-II

Overlaps with: Nil

Course Outcomes/ Objectives:

1. To explain the students about the basics and practical significance of Dynamics of Machine
2. To expose the students to basic principle of governing the motion of mechanical systems
3. To enable students to apply mathematical approaches to solve engineering problems related to the dynamics of machine
4. To develop their skill in analysis and control of their motion and enable students for higher studies and research

Mapping with POs:

POs → COs ↓	PO1	PO2	PO3
CO1	H	H	M
CO2	H	H	M
CO3	H	H	H
CO4	L	M	H
Overall	H	H	M

CONTENT

Basic Concepts: Functional Laws of Motion, Mechanics of Particles and System of Particles, Inertia Coordinate System, Principles of Linear and Angular Momenta, Work-energy principles.

Lagrangian Dynamics: Degrees of Freedom, Generalized Coordinates and Generalized Forces, Holonomic and Non-holonomic Constraints, Lagrange's Equation from D' Alembert's Principles, Application of Lagrange's equation for Conservative and Non-conservative with holonomic and Non-holonomic Constraints, Applications to systems with very Small Displacements and Impulsive Motion.

Hamilton Dynamics: Hamilton Principle from D' Alembert's Principle, Lagrange Equation from Hamilton's Principle

Multi-body Dynamics: Space and Fixed body Coordinate Systems, Coordinate Transformation Matrix , Direction Cosines, Euler Angles, Euler Parameters, Finite and Infinitesimal Rotations, Time Derivatives of Transformations Matrices, Angular Velocity and Acceleration Vectors, Equations of Motion of Multi-Body System, Newton-Euler Equations, Planer Kinematic and Dynamic Analysis, Kinematic Revolute Joints, Coordinate Partitioning, Equations of Motion, Joint Reaction Forces, Simple Applications of Planer Systems.

Stability of Motion: Fundamental Concept in Stability, Routh's Criteria for Stability, Lyapunov Method,

Text/Reference Books:

Lyapunov's Stability Theorems, Lyapunov's Function to Determine Stability of the System.

J. H. Ginsberg, "Advanced Engineering Dynamics", Harper and Row, 1988

L. Meirovitch, "Methods of Analytical Dynamics", McGraw Hill Inc, 1970

Greenwood "Principles of Dynamics", Prentice Hall Inc, 1987

Goldstein, "Classical Mechanics", Addison Wesley, 1983

R .H. Canon, "Dynamics of Physical System", McGraw Hill Inc, 1967

VII Semester

MED401PROJECT PHASE-I
2 credits
Pre-requisites: NIL
Overlaps with:
Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

MEL435COMPUTATIONAL FLUID DYNAMICS

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : At the end of this course, the student will be able to:

1. Understand and be able to numerically solve the governing equations for fluid flow
2. Understand and apply finite difference, finite volume and finite element methods to fluid flow problems
3. Understand how grids are generated
4. Understand how to assess stability and conduct a grid-convergence assessment
5. Understand and apply turbulence models to engineering fluid flow problems
6. Understand and apply compressible flow solvers
7. Understand the issues surrounding two-phase flow modelling
8. Be able to numerically solve a heat transfer problem
9. Be able to use ANSYS CFX to an acceptable standard for a graduate engineer.

Content:

Equations of fluid dynamics

Basic concepts Eulerarian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, vorticity. Laws governing fluid motion, continuity, Navier – stokes & energy equations. Boundary layer equation, Euler equations, potential flow equations, Bernoulli's equation and vorticity transport equation.Initial and boundary conditions.

Classification of equation of motions – hyperbolic, parabolic, elliptic.

Mathematical Preliminaries

Numerical integration. Review of linear algebra, solution of simultanilus linear algebric equations – matrix inversion, solvers – direct methods, elimination methods, ill conditioned systems; Gauss- Sidel method, successive over relaxation method.

Grid Generation

Transformation of coordinates.General principles of grid generation – structured girids in two and three dimensions, algebric grid generation, differential equations based grid generation; Elliptic grid generation, algorithm, Grid cluistering, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation. Techniques for complex and large problems: Multi block methods.

Finite difference discretisation

Elementary finite difference coefficients, basic aspects of finite difference equations, consistency, explicit and implicit methods, errors and stability analysis. Stability of elliptic and hyperbolic equations. Fundamentals of fluid flow modeling-conservative property, upwind scheme, transporting property, higher order upwinding. Finite difference applications in heat transfer – conduction, convection.

Finite Volume Method

Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretised equations using TDMA.Finite volume methods for unsteady problems – explicit schemes, implicit schemes. Finite Element Method: Introduction. Weighted residual and variational formulations. Interpolation in one-dimensional and two-dimensional cases. Application of FEM to ID and 2D problems in fluid flow and heat transfer

Text Books/ Reference Books:

1. Ferziger J. H., Springer P.M, “Computational Methods for fluid Dynamics”, Verlag Berlin
2. Anderson J. D. JR, “Computational fluid Dynamics”, McGraw Hill Inc, 1995
3. Patankar S. P, “ Numerical Heat Transfer & Fluid flow”
4. Sunderarajan M.K., “Computational Fluid Flow and Heat Transfer”, 2nd Ed, Narosa Publishing

MEP435 COMPUTATIONAL FLUID DYNAMICS

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

1. To provide students with the necessary skills to use commercial CFD packages
2. To carry out research in the area of Computational Fluid Dynamics.
3. To solve a variety of flow situations and heat transfer tutorials.

Content:

The set of tutorials designed to provide the student with the necessary tools for using sophisticated commercial Ansys fluent CFD software. A set of laboratory tasks will take the student through a series of increasingly complex flow and heat transfer simulations, requiring an understanding of the basic theory of computational fluid dynamics (CFD).

At the end of the course each student will have to complete a mini project.

Text Books/ Reference Books

MEL420 FINITE ELEMENT METHOD

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : Upon completing this course, the students will be able to:

1. Identify mathematical model for solution of common engineering problems.
2. Formulate simple problems into finite elements.
3. Solve structural, thermal, fluid flow problems.
4. Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.
5. Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts

Content:

Introduction to variational methods in boundary value problems. Rayleigh-Ritz method.

Concept of finite elements. Brief introduction to finite analysis. Discretisation, approximation and assembly of finite elements, Strain-displacement and stress-strain relations for plain-stress, plain-strain and axismmetric problems. Temperature effect.

Finite element modeling of 1-D problems. Langranian and Hermitian shape functions, element stiffness matrix and load vector. Assembly of global stiffness matrix and global load vector. Boundary constraints and solution for nodal displacements. Convergence criteria and compatibility requirement. Higher order elements. Weak formulation, Gelerkin FEM and non-linear problems. Eigen value problems of 1-D models, vibration of bars. 2-D problems with constant strain triangles. Co-ordinate transformation and Jacobian. Straight sided and curved sided elements. Gauss-quadrature integration formula.

Beam flexure modeling with finite elements. Vibration of beams. Plate bending problem with triangular, rectangular, and curve sided elements. Types of curve sided elements. Triangular and rectangular isoperimetric elements. Sub parametric and super parametric elements. Finite element modeling of incompressible inviscid fluid flows and steady state heat conduction problem.

Text Books/ Reference Books:

1. Cook, R.D, "Concepts and application in Finite Element Analysis", 3rd Ed, The Wiley & Sons
2. Chandragupta, Bellegundu, "Introduction to Finite Element Engineering", 2nd Ed , Prentice Hall
3. Huebner et al. , FEM for Engineers, John Willey and Sons
4. J N reddy, Introduction to FEM, Tata McGraw Hill
5. S Srao, Finite element method in engineering, 5th Ed. Bitterworth Heinemann

MEP420 FINITE ELEMENT METHOD

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

1. Equip the students with the Finite Element Analysis fundamentals,

2. Enable the students to formulate the design problems into FEA,

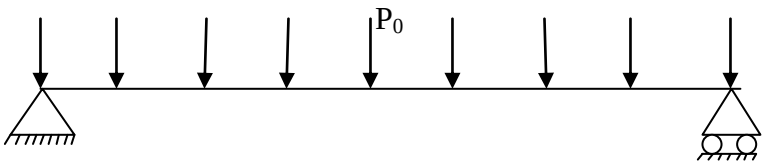
3. Enable the students to perform engineering simulations using Finite Element Analysis software (ANSYS & LSDYNA).

4. Enable the students to understand the ethical issues related to the utilization of FEA in the industry

Content:

1.Write a computer program to solve the differential equation of the form $a*(d^2y/dx^2) + (b*y) + c = 0$ where a, b, c are constants which may be positive or negative.

2. Write a computer program to find the displacement by using finite displacement method.

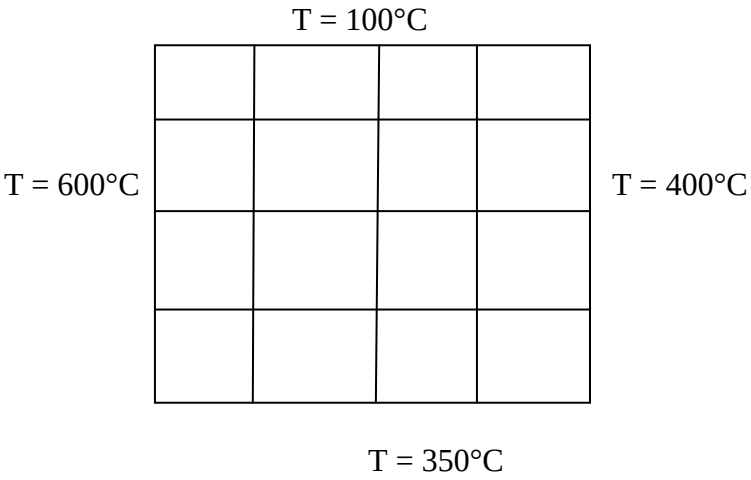


P_0 – Load per mm (N/mm)

d – Diameter of beam (mm)

Divide the continuum in 6 parts.

3. Write a computer program to find the temperature distribution.



Heght = 500mm Width = 500mm

1. To find the Inverse matrix of Shape function for CST, Truss and Beam elements and verify it mannualy and in Ansys.
2. To write a program code for1D bar element numerical and their comparison with manual and Ansys results.
3. To write a program code for a CST elements with force and boundary conditions to obtain displacement, strain and stress at each node and compare with manual and Anssys result
4. To write a program code for a Truss with force and boundary conditions to obtain displacement, strain and stress at each node and compare with manual and Anssys result
5. To write a program code for a 2D elements with force and boundary conditions to obtain displacement, strain and stress at each node and compare with manual and Anssys result

Text Books/ Reference Books:

MEL410 COMPUTER AIDED DESIGN

3 credits (3-0-0)

Pre-requisite: Nil

Overlaps with:

Course Outcomes/ Objectives:

Upon successful completion of this course you should be able to:

1. Understand the engineering design process and its role in graphic communication process.
2. Generate and interpret engineering technical drawings of parts and assemblies according to engineering design standards.
3. Use CAD software to generate a computer model and technical drawing for a simple, well-defined part or assembly.
4. Fluent application of engineering techniques, tools and resources
5. Effective oral and written communication in professional and lay domains

Mapping with POs:

Content:

CAD Introduction: Need of machine design, use of computer, computer fundamentals, computer

aided design process, CAD configuration, CAD tools, positive and negative points of CAD, CAD and CAM integration.

CAD Hardware: Introduction to hardware specific to CAD, CRT, Random scan technique, raster scan technique, DVST, Raster display, Display systems, sequential scanning and interlaced scan.

CAD Software: Introduction to software specific to CAD, output primitives, line generation algorithm, circle generation, plane curve, transformation, windowing and clipping, line clipping technique, geometrical modeling, CSG technique & B-rep technique.

Finite element method: Introduction, principle of minimum potential energy, types of element, shape function, elemental strain displacement matrix, types of forces, elemental stiffness matrix, elemental force matrix, assembly, truss, introduction to 2 dimensional finite element method.

Optimization: Introduction, Johnson method of optimization normal specification problem, redundant specification problem, introduction to genetic algorithm.

Newer techniques of CAD: Rapid prototyping, laser and non-laser process of rapid prototyping, STL formal of CAD file, introduction to reverse engineering and related software's viz. rapid form.

Text Books/ Reference Books:

1. Zeid I., "CAD / CAM problem & practice", 3rd Edition, Tata McGraw Hill, 2001.
2. Newman, Sproull. "Principles of interactive computer graphics", Mc Graw Hill book Co., 1981.
3. Bathe K.K., "Finite Element Procedures",Prentice Hall of India, 1996.
4. Kuthe A.M., "Computer Graphics including CAD, AutoCAD & C", 1st Edition,S.Chand, 2005
5. Rao P.N., "CAD/CAM principles &applications", Tata Mc Graw Hill, 2002.

MEP410 COMPUTER AIDED DESIGN (Lab)

1 credit (0-0-2)

Pre-requisites: Nil

Overlaps with:

Course Outcomes/ Objectives:

Upon successful completion students will be able to:

1. Operate graphics software for various Cad applications
2. Carry out programming for optimization of design
3. Use customized FEM software for real application of CAD

Mapping with POs:

Content:

1. Development of software for design of any mechanical element and system.
2. Development of menu driven software for graphics using output primitives.
3. Development of software for transformation using scaling, rotation, reflection.
4. Development of software for clipping of graphical entities.
5. Development of software for analysis of one dimensional element using FEM technique.
6. Software operation of customized FEM software.
7. Development of computer program for analysis of mechanical element using FEM for user input values.
8. Development of software for analysis of stress problem using FEM.
9. Development of software for design optimization of mechanical element using Johanson method. Use of commands of any computer aided drafting software package viz. AutoCAD, Pro-engineer.

Text Books/ Reference Books:

MEL436MECHATRONICS
3 credits (3-0-0)
Pre-requisites: NIL
Overlaps with:

Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

MEP436MECHATRONICS
1 credits (0-0-2)
Pre-requisites: NIL
Overlaps with:

Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

MEL407 BIOMECHANICS

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :Student will be able to:

1. Apply a broad and coherent knowledge of the underlying principles and concepts of biomechanics, particularly in the fields of kinematics and kinetics as applied to human and projectile motion.

2. Safely and effectively use biomechanics instrumentation and equipment to record and assess

human and object motion.

3. Record, extract and analyse key information about teeth, muscles, bones etc.

4. Using basic knowledge develop tools, devices or softwares for the medical practitioners.

5. Address complex problems with engineering and scientific solutions.

Mapping with POs:

CO/ PO	a	b	c	d	e	f	g	h	i	j	k
CO1	H	--	H	L	M	L	H	L	L	H	H
CO2	-	L	--	H	H	--	M	H	H	-	H
CO3	M	H	L	H	--	H	H	M	H	H	M
CO4	H	M	H	--	L	H	L	L	M	M	-
CO5	M	H	M	M	H	L	M	H	M	H	H
Overall	H	M	M	H	H	M	M	M	H	M	H

Content:

Unit I. Definition of Biomechanics, Selected Historical highlights, The Italian Renaissance, Gait century, Basic Mechanics, Anatomical Terminologies, Movement terminologies, location Terminologies, Human bodies and its classification as levers, Numericals.

Unit II. Biological materials, Brief Anatomy, Bone, cartilage, ligament, tendon, Muscles, their physical properties, degree of freedom of joints. Disorders of joints.

Unit III. Effect of Exercise, aging, Disuse on all the hard and soft tissues of Musculo-skeletal system. Combined effects of drugs and exercise, aging and exercise, effect of log term rest. Muscle fatigue and its assessment.

Unit IV. Dental Biomechanics, Function of dentin, pulp, periodontal ligament. prosthodontics, orthodontics, Periodontics, Endodontics, Related projects and case studies.

Unit V. Measuring techniques for force, pressure distribution, acceleration, Optical methods, strain measurement, inertial properties of human body. General considerations for modeling, types of model, validation of model, force system analysis, assumptions, free body diagrams, Simulation, Numerical solution methods, Muscle models, modeling of external forces, optimization studies, simulation as a scientific tool.

Text Books/ Reference Books:

1. Nigg, B.M.and Herzog, W., "BIOMECHANICS of Musculo skeleton system", John Willey & Sons, 1st Edition.
2. Saltzman, W.L., "BIOMEDICAL ENGINEERING: Bridging medicine and Technology", Cambridge Text, First Edition.
3. Winter, D., "BIOMECHANICS and Motor Control of Human Movement", WILEY Interscience Second edition

MEL414TRIBOLOGY

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

By the end of the course student should:

1. Have a knowledge of surface topography and know how to model a rough engineering surface
2. Have a clear overall picture about the basics of tribology and related sciences, theoretical background about processes in tribological system, mechanisms and forms of interaction of friction surfaces
3. Understand Hertz contact and rough surface contact
4. Be familiar with adhesion theories and the effect of adhesion on friction and wear
5. Have a mastery of the friction/lubrication mechanisms and know how to apply them to the practical engineering problem

Content:

Introduction to tribology. Basics of friction, wear and lubrication.

Study of lubricants, their properties and compositions.

Study of Hydrodynamic Lubrication, Principal of pressure generation between the non parallel surfaces, Derivation of Reynolds's equation, Long and short bearing approximations, Evaluation of tribological performance such as pressure distribution, load carrying capacity, lubricant flow.

Hydrostatic lubrication, working and construction details, Evaluation of tribological

performance.

Squeeze film lubrication, working and construction details, Evaluation of tribological performance.

Elasthydrodynamic lubrication

Boundary/ Extreme pressure lubrication.

Surface Topography

Friction, laws of friction

Wear, Abrasive wear, Erosive wear, Adhesive wear, Fatigue wear.

Antifriction bearings

Text Books/ Reference Books:

1. Cameron, A. "Basic Lubrication Theory", John Wiley & Sons, Incorporated, Second Edition, 1977
2. Gwidon W. Stachowiak and Andrew W. Batchelor, "Engineering Tribology", Elsevier, Third Edition (ISBN: 978-0-7506-7836-0)
3. Majumdar, B.C. , "Introduction to Tribology of Bearings", S. Chand
4. Basu, S.K., Sengupta, S.N., Ahuja, B.B., "Fundamentals of Tribology", PHI

MEL433 DESIGN FOR MANUFACTURING AND ASSEMBLY

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with: NIL

Course Outcomes/ Objectives :Upon completing this course,

1. Student will have knowledge of basic manufacturing processes and their capabilities
2. Student will select appropriate material, process and features for a design
3. Student will design products which are easy for assembly & manufacturing
4. Student will evaluate the design for alternatives of manufacturing

Mapping with POs:

POs →	a	b	c	d	e	f	g	h	i	j	k

COs ↓											
CO1	M	L	L	L	----	L	L	L	M	L	H
CO2	H	L	H	M	----	L	L	M	M	L	H
CO3	H	L	H	M	----	M	M	M	M	L	H
CO4	H	H	H	M	----	H	H	M	H	H	H
Overall	H	L	H	M	----	M	M	M	M	L	H

Content :

Introduction – Definition, History, Advantages and Impact . Selection of materials and processes – General requirements, process capabilities, Systematic selection of processes and materials, design examples (CO1)

Product design for manual assembly – General guidelines, systematic design for assembly, effect of various design features on manufacturing, design examples (CO2, CO3, CO4)

Design for high speed automatic and robotic assembly – Design for high speed feeding and orientating, High speed inspection, Analysis of assembly, design examples(CO2, CO3, CO4)

Design for machining – Design for single point / multi point / abrasive machining, assembly of components, accuracy and surface finish, cost estimating, design examples (CO2, CO3, CO4)

Design for injection moulding – Injection moulding materials, moulding cycles, estimation of optimum number of cavities, design examples(CO2, CO3, CO4)

Design for sheet metal working – Dies and Press working, Press selection, Design rules (CO2, CO3, CO4))

Design for sand casting, die casting, investment casting – Materials, Basic characteristics of process and mould features, cost estimating, design rules for different castings.(CO2, CO3, CO4)

Design for forging – characteristics, cost estimation and design rules(CO2, CO3, CO4)

Text Books/ Reference Books:

1. Boothroyd, G., Dewhurst, P., Knight, W. A. “Product Design for Manufacturing and Assembly”, Third Edition, CRC Press, 2011.

2. Allen, C. W., “Simultaneous Engineering -Integrating Manufacturing and Design”, Society of Manufacturing Engineers, Nov. 1990.

3. James Bralla, “Design for Manufacturability Handbook” McGraw Hill, 2004.

4. Anderson, D.M., "Design for manufacturability & concurrent engineering: how to design for low cost, design in high quality, design for lean manufacture, and design quickly for fast production," CIM press, 2nd Edition, 2010.

MEL412 AIR CONDITIONING

3 credits (3-0-0)

Pre-requisites: Nil

Overlaps with: Nil

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

1. understand various definitions and theoretical concepts related to air conditioning like psychrometrics and psychrometric processes etc to meet UG level requirement.
2. understand the concepts related to comfort and its measurement, effective temperature, comfort chart and its use, methods of cooling load calculations, design process for summer /monsoon/winter air conditioning and duct design.
3. understand working of various equipments/systems used in air conditioning like air washers, fans, pumps, pan humidifiers and room/package/central type air conditioners from undergraduate perspective.

4. understand and apply mathematical treatment to various problems related to psychrometrics, psychrometric processes, design of summer/ winter/monsoon air conditioning and duct design to reasonable correctness.

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**

CO1	H	H	M	M	H	M	M	M	L	M	H
CO2	H	H	M	M	H	M	M	M	L	M	H
CO3	M	M	M	M	L	M	M	M	L	M	H
CO4	H	M	M	M	H	M	M	M	L	M	H
Overall	H	H	M	M	H	M	M	M	L	M	H

Content:

1 Fundamentals of Air conditioning: Introduction to air conditioning, psychrometrics, important terms and definitions, enthalpy of air, adiabatic saturation temperature, measurement of properties, psychrometric chart, its construction and use. **CO1,CO4**

2. Psychrometric processes: Mixing, mixing with condensation, sensible heating and cooling, humidification and dehumidification, bypass factor and its role, evaporative cooling, drying process, working of air-washer. **CO1,CO4**

3. Air-conditioning System Design: Sensible heat factor, design of summer air conditioning system, calculation of dehumidified air quantity and apparatus dew point, ERSHF method, air-conditioning systems for monsoon and winter, air conditioning systems using all fresh air.
CO2,CO4

4. Comfort and Cooling load Estimation: Comfort and its requirements, mechanism of body heat loss, effect of heat on body and body defense mechanism, effective temperature, factors affecting human comfort, comfort chart and its use, Cooling load estimation, components of cooling load, sensible and latent loads, ASHRAE and CARRIER methods of load estimation.
CO2

5. Industrial practices in Air conditioning: General layout of central air conditioning Plant, chilled water and condenser water piping, selection of pump. Fans, types and characteristics, commissioning and testing of air conditioning systems. Applications of air conditioning, working of room air-conditioner and split air-conditioner and packaged air-conditioner.
CO3

6. Air Distribution and duct design: Components of air handling systems, principles of air distribution,

types of supply and return air openings and related definitions, considerations for selection and location of supply and return air openings. **Duct design**: General duct design, rules, principles of duct design, equivalent diameter of ducts, ducting materials, frictionchart and its use, methods of duct design.
CO2,CO4

Text Books/ Reference Books:

1. C.P. Arora , 'Refrigeration and air conditioning ',Tata Mcgraw Hill, Third edition,2016
2. P.L Ballaney, ' Refrigeration and air conditioning' ,Khanna Publishers, 16th edition,2013
3. S. Domkundwar, 'A course in Refrigeration and Air conditioning', Dhanpatrai publication,1980
4. P N Ananthanarayanan, 'Basic Refrigeration and Air Conditioning', McGraw Hill, Fourth edition,2013
5. Pita Edward, 'Air conditioning principles and systems', Prentice hall, 4th edition
6. ASHRAE Handbook: Fundamentals,2017
7. ASHRAE Handbook : HVAC systems and Equipments,2016
8. Carriers Handbook of Air conditioning system design

MEL431 ADVANCED MECHANISM

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

1. Students gain a solid theoretical background in kinematics and in the analysis and synthesis of mechanisms.
2. Students become familiar with basic and advanced computer-based engineering tools for the analysis and design of linkages.
3. Students have the ability to apply theory and the use of practical engineering tools in a substantial mechanism design project.

Content:

Introduction to kinematics, types of mechanism, kinematics synthesis, science of relative motion, tasks of kinematic synthesis with practical applications, Degree of freedom, class-I, class-II chain, Harding's notation, Grashof criterion, Grubler's criterion. Introduction to position generation problem, concept of pole, two & three position generation synthesis, pole triangle, Relationship between moving & fixed pivots, Four position generation, opposite pole quadrilateral, center point & circle point curve, Burmester's point. Matrix method for position generation problem, rotation matrix, displacement matrix.

Introduction to function generation problem, co-ordination of input-output link motion, relative pole technique, inversion technique, overlay technique, graphical synthesis of quick return mechanisms for optimum transmission angle. Types of errors, accuracy points chebyshev's spacing and frudenstein's equation. Introduction to path generation problem, synthesis for path generation with and without prescribed timing using graphical method. Coupler curves, cognate linkages, Robert's law of cognate linkages. Complex number method for path generation problem 3 precision point. Synthesis for infinitesimally separated position, concept of polode and centrod, Euler's savery equation, inflection circle, Bobbilier and Hartman's construction. Optimal synthesis of planer mechanisms, least square method. Introduction to spatial mechanisms, D-H notations, Introduction to kinematic analysis of robot arms.

Text Books/ Reference Books:

1. Tad D.C, "Applied linkage synthesis", Addison Wesley publication , 1964.
2. Sandor G.N., Erdman, A. G, "Advanced mechanism design", Prentice Hall Inc, 1984
3. Suh C.H., Radcliff C.W ," Kinematics and mechanisms design", John Wiley &Sons., 1978.

MEL 437 COMPOSITE MATERIALS

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : Upon completing this course,

1. Student would be able to understand behavior and specialties of orthotropic materials.
2. They will be able to find appropriate applications where a particular composite can be used.
3. Students will also have sound understanding of theory of elasticity and mechanics of orthotropic materials and behavior under bi-axial stress conditions.
4. Students will learn the concept of design optimization with proper material selection.

Content:

Introduction to composite materials, evolution and applications in engineering. Characteristics and classification of composite materials; Fibrous, laminated and particulate composites. Basic terminologies; volume fraction and weight fraction. Laminae and laminates. Different fibres, matrices and their properties. Advantages and disadvantages of polymer matrix composites, metal matrix composites and ceramic matrix composites.

Mechanical properties of unidirectional composite lamina. Longitudinal and transverse Young modulus, shear modulus, Poisson ratio. Empirical relationship of Halpin-Tsai. Longitudinal and transverse Strength. Composites under compressive loading.

Properties of angle ply lamina. Transformation of Young moduli, shear modulus. Concept of coupling coefficients. General and special orthotropic materials. Psai Pagano invariants

Strength of orthotropic lamina. Biaxial strength theories. Maximum strength, maximum strain theory. Tsia-Hill maximum work theory. Tsai Wu tensor theory. Applications to pressure vessels, composite shafts etc.

Codes and engineering representation of Laminates. Macro mechanical behavior of a laminate. Laminate stiffness for different types; symmetric, anti-symmetric, cross ply laminates. Stresses in different laminae in a laminate. Configurations and design of laminates for special properties

Strength and mechanism of failure in a composite laminate. Concept of FPF(First Ply Failure and total failure). Hygroscopic and thermal stresses.

Text Books/ Reference Books:

1. Mallick, P. K. , “Fibre-Reinforced Composites, CRC press,” New York, 2007
2. Jones, R.M., “Mechanics of Composite Materials,” McGraw Hill, New Delhi
3. Broutman and Agarwal, “Analysis and Performance of Composite materials”, John Willey and Sons, New York

MEL408 SUPPLY CHAIN MANAGEMENT

Course Outcomes/ Objectives :

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

1. Create and define various nodes and its relationships in a network.
2. Outline the structure of supply chain for a dedicated application.
3. Identify the basic elements and its role in SC
4. Apply the various practices of SC on a real life or simulated network.
5. Compare and contrast the multiple determinants of SC nodes.

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	L	H	H	L	H	L	H	L	H	L	L
CO2	L	H	H	L	H	L	H	L	H	L	L
CO3	L	H	H	L	H	H	H	L	H	L	L
CO4	L	H	H	L	H	H	H	H	H	H	L
CO5	L	H	H	L	H	L	H	L	H	L	L
Overall	L	H	H	L	H	L	H	L	H	L	L

Content:

- INTRODUCTION TO STRATEGIC VIEW OF SUPPLY CHAINS: Role of supply chain management (SCM) in economy, Organization and challenges, decisions, Supply chain

strategy and performance measures, Build-to-Order, Build-to-Stock, and the Push-Pull Point, supply chain drivers and Metrics : Service Metrics, Inventory Metrics, Speed Metrics, Financial Metrics, Bullwhip Metric, Bad Metrics, Trade-off Curves, The Bullwhip Effect, Outsourcing.

- MANAGING MATERIAL FLOW IN SUPPLY CHAINS: Inventory Management, Transportation, Network design and Facility location operation.

- MANAGING INFORMATION FLOW IN SUPPLY CHAIN: Demand Forecasting, Information technology, SCM-softwares.

- SUPPLY CHAINS INNOVATION: Supply Chain Integration, cross functional drivers, Supply chain restructuring, agile supply chains, Pricing and revenue, The Internet and Supply Chain Management, B2B Integration.

- CASE STUDY: National and International. the supply chain, its performance, drivers and its metrics; Design of the supply chain network, Planning demand and supply in a supply chain, Planning and managing inventories in a supply chain, Planning and managing inventories in a supply chain, Designing and planning transportation networks, Managing cross-function drivers in a supply chain, Bullwhip effect, National and International case studies in a supply chain

Text Books/ Reference Books:

1. Sunil Chopra and Peter Meindl , "Supply Chain Management", Pearson – Prentice Hall publication. Ist and IInd edition
2. Janat Shah, "Supply Chain Management", Pearson education Publication, Ist edition.
3. SpigelM.R , "Probability and statistics", McGraw Hill Book Co, 1980.
4. HartmutStadtler, ChristophKilger; Supply Chain Management and Advanced Planning - Concepts, Models, Software, and Case Studies; Springer Publication.
5. Dmitry Ivanov, Boris Sokolov; Adaptive Supply Chain Management; Springer Publication.
6. Terry P. Harrison, Hau L. Lee, John J. Neale; The Practice Of Supply Chain Management: Where Theory And Application Converge; Springer Publication.
7. Andrew Cox, Paul Ireland, Chris Lonsdale, Joe Sanderson and Glyn Watson; Supply

Chain Management - A guide to best practice; Pearson education limited.

8. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the supply chain: Concept, Strategies and case studies, McGraw Hill Publication.
9. James B. Ayers; Handbook Of Supply Chain Management; St. Lucie Press.

MEL425 RELIABILITY AND MAINTENANCE ENGINEERING

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :Students successfully completing this course should be able :

1. To equip the graduate to plan, design, and execute effective maintenance strategy and maintenance practices in various types of industries.
2. To equip graduates with the state of the art maintenance repair techniques and condition monitoring technologies and instrumentation.
3. To equip graduates with the essentials of reliability engineering techniques to enable them to develop and enhance reliability programs.

Mapping with POs:

POs → / COs ↓	a	b	c	d	e	f	g	h	i	J	K
CO1	H	L	H	-	-	H	H	M	-	M	-
CO2	H	H	L	L	-	-	M	-	M	M	-
CO3	H	H	M	-	L	M	L	H	M	H	-
Overall	H	M	M	L	L	M	M	M	M	M	-

Content:

Plant Maintenance : A Conceptual Framework **[CO1]** , Maintenance Strategies**:** planned/unplanned maintenance, breakdown, corrective. Opportunistic, routine, preventive, predictive maintenance: condition based maintenance system, design-out maintenance, selection of maintenance system. MaintenancePlanning. Maintenance Scheduling, Spare Parts Management, Replacement Analysis, Codification and cataloguing, history cards, instruction and operation manuals, maintenance work order and work permit etc. Computerized Maintenance Management System, E-Maintenance. **[CO1]**

Maintenance defect failure analysis and repair techniques: Defect recording and failure analysis. breakdown analysis (FTA, FMEA), dismantling and assembling, inspection and adjustment, lubrication. Maintenance cleaning, welding, metal spraying, metal stitching, thread

inserts, Electro-disintegration machine etc. **[CO2]**

Machinery condition monitoring: Fundamentals of machine vibrations, Digital Signal Processing, Instrumentation, Vibration Monitoring, Noise Monitoring, Thermography, Wear debris analysis, Motor current signature analysis, other techniques such as Ultrasonic testing, Radiography, Eddy current testing etc. **[CO2]**

Reliability Oriented Maintenance Systems and Evaluation: Elements of Probability, Reliability definition, Failure data analysis, Analysis of Failure Data, Overview of estimation techniques, Distribution Fitting, Hazard Models, System Reliability, Reliability Improvement, FTA and other techniques, Maintainability and Availability, Repairable systems. **[CO3]**

Other topics: TPM, RCM, Six Sigma Maintenance, Lean Maintenance, Five zero maintenance, 5-S concept, OEE, Software reliability, HAZOP, Human Reliability. Industrial Safety. **[CO3]**

Text Books/ Reference Books

1. Srivastava S K, "Industrial Maintenance Management", S. Chand, 1998
2. L.S. Srinath , "Reliability Engineering", Affilated East-West Press , 4th Edition 2005
3. Williams, "Condition Based Maintenance and Machine Diagnostics " Chapman & Hall

MEL440MACHINE VISION & ITS APPLICATION

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :On completion of this course, students will be

1. Aware about the world of computer vision that goes beyond image processing algorithms.

2. Getting knowledge and an understanding of artificial vision from a practical implementation perspective

3. To design vision systems for mechanical engineering applications like surface metrology, autonomous navigation and inspection, medical imaging

Mapping with POs:

POs →	a	b	c	d	e	f	g	h	i	j	k

COs ↓											
CO1	H	-	H	H	H			M	M	M	
CO2	L	M	L	L	M			M	L	M	
CO3	M	H	M	M	H			H	M	H	
Overall	M	M	M	M	H			M	M	M	

Content:

Basics of computer vision: Nature of images, homogeneous transformations, quaternions, geometrical and optical image formation, perspective projection, camera technologies and vision systems design. (CO1)

Basics of image processing : Filtering, edge detection, features detection, contours, segmentation, morphological operators. (CO2)

Calibration: Camera model, intrinsic and extrinsic camera parameters, camera calibration. (CO2)

Motion: Motion detection, optical flow, object tracking. Three-dimensional imaging :Epipolar geometry, stereoscopic vision, active range imaging, structured lighting. (CO2)

Modeling and registration : Modeling techniques for autonomous systems, data fusion, uncertainty mapping, registration, pose estimation (CO3)

Applications: Quality control, surface metrology, inspection, mapping and robot guidance, motion estimation, autonomous systems, biomedical imaging devices. (CO3)

Text Books/ Reference Books:

1. Gonzalez, R. C. , Woods, R. E. and Eddings, S. L. Digital, “Image Processing using Matlab”, Pearson Prentice Hall, 2004
2. Tinku Acharya, Ajoy K. Ray, “Image Processing: Principles and Applications”, Wiley, 2005
3. Demant, Christian, Streicher-Abel, Bernd, Garnica, Carsten, “Industrial Image Processing: Visual Quality Control in Manufacturing”, Springer-2016

MEL452 ADVANCED MACHINING PROCESSES

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

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

1. Illustrate advanced machining processes, cutting tools and cutting fluids for a specific material and part features.
2. Relate Generation and control of electron beam for machining, laser beam machining, comparison of thermal and non-thermal processes
3. Differentiate Thermal Metal Removal Processes, characteristics of spark eroded surface, machine tool selection and various finishing techniques.

Content:

Advanced Metal Cutting and Grinding :Modeling of cutting process: Review of cutting mechanism; Cutting force model; Oblique Cutting; Temperature analysis (Finite Difference Method); Wear model; Evaluation of surface quality; Cutting processes for producing various shapes

Gear machining: Hobbing , Modeling of grinding process: Grinding force model; Temperature analysis; Wheel life model., Introduction of finishing process: Machining mechanism in finishing: Honing, Lapping, Super finishing, etc.

Micro-Nano Precision Machining: Introduction to nano-precision mechanical manufacturing: M4 processes

Nano-precision cutting: Machine & tool; Brittle / ductile transition; Ductile mode cutting of brittle materials

Nano-precision grinding: Machine & grinding wheel; Truing & dressing; Cutting edge evaluation; Applications to extreme optics, Nano-precision polishing: Conventional polishing; Non-conventional polishing; Plane honing; Field-assisted fine finishing

Unconventional Machining Processes :Electric Discharge Machining (EDM); Electron Beam Machining (EBM); Plasma Arc Machining (PAM); Laser Beam Machining (LBM); Ultrasonic Machining (USM); Abrasive Jet Machining (AJM); Water Jet Cutting (WJC), Abrasive Water Jet Machining (AWJM); Electro-Chemical Machining (ECM); Chemical Machining (CHM)

Text Books/ Reference Books:

1. Boothroyd, G and Knight, W A., "Fundamentals of Machining and Machine Tools", 3rd Third Edition, Saint LuicePr, 2005.
2. G.F. Benedict, "Non-traditional Manu. Processes", Marcel Dekker, Inc. New York, 1987.
3. P.C. Pandey, and H.S. Shan, "Modern Machining Processes", Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 1980.
4. J.A. McGeough, "Adv. Methods of Machining", Chapman and Hall, London, 1988.

MEL417POWER PLANT ENGINEERING

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :On Successful completion of this course, The student will :

1. Know the various types of power plants used in Jordan.
2. Have Knowledge of the various types of conventional and non-conventional power plants.
3. Have Knowledge of the operation, construction and design of various components of power plants.
4. Able to calculate the performance parameters of various power plants.

Content:

Steam Power Plant: Reheat-regenerative cycle, binary cycle, topping and superimposed cycle.

Steam generators: Modern generators, once through and fluidized bed boilers design. Consideration of modern steam generators, furnace, fuel firing methods, fuel and ash handling systems, various accessories of steam generators, steam temperature control.

Steam Turbines: Details of construction, accessories, governing, turbine blades, power calculations, arrangement of turbines, industrial turbines.

Condensers and Cooling Towers: Performance, heat transfer design, calculations, efficiencies, detail construction, cooling water circuit, environmental aspects.

Hydro Electric Plant: Hydrology, rainfall measurement hydrographs, flow duration curves, site selection, classification of hydro stations, capacity of hydro stations, selection of prime movers, governing of water turbines, operation of different components of hydro station reservoirs, dam,

spillway, canals, penstock, water hammer surge tank, Draft-tubes, specific speeds of turbines, Advantages of hydro station.

Gas Turbine Power Plant: General features and characteristics and their application power plants, Analysis of different cycles, components of gas turbine power plants, governing system of gas turbine plant, advantages of G. T. plant, Gas and steam turbines, combined cycles – Thermodynamic analysis for optimum design, advantages and performance of combined cycles, economics of combined cycle. Combined cycle with nuclear power plants, Diesel electric power plant: Thermodynamic cycle analysis, supercharge of diesel engines, different systems of diesel power plant, environmental aspects. Power Plant Economics: Fluctuating load on power plants, load curves, various performance factors of power station. Effect of variable load power plant design and operation. Economic analysis of power plants, tariffs, load division, combined operation of different power plants, heat rate, incremental heat rate, selection of power plant and station equipments

Text Books/ Reference Books:

1. Strotzski, Vopat, "Power Station Engineering & Economy", Tata McGraw Hill, 1977
2. Domkundawar, "Power Plant Engineering", DhanpatRai& Sons,1980
3. P K Nag, Power plant engineering, McGraw Hill
4. Black and Veatch, Power plant engineering, CBS publishers

MEL402 SURFACE ENGINEERING

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : Upon completing this course the students should be able to:

1. Demonstrate an understanding and critical awareness of the concepts of surface engineering
2. Demonstrate a sound knowledge for the systematic application of alternative technologies used to fabricate coating systems.
3. Recommend techniques used to characterize the surface and explain the principles behind their operation.
4. Select the most suitable surface engineering techniques that would give the required properties

Mapping with POs:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	M	L	-	H	-	-	H	H	H	-	H
CO2	H	H	H	H	-	L	H	H	H	-	L
CO3	H	M	L	H	-	-	H	L	H	H	M
CO4	M	M	L	H	-	L	H	M	H	-	L
Overall	H	M	L	H	-	L	H	H	H	M	M

Content:

Need for surface engineering, Classification of surface engineering methods and Surface Preparation. Surface Hardening without modification of surface chemistry - Induction hardening, Flame hardening, Laser beam hardening and Electron beam hardening.
Thermo Chemical Diffusion Treatments - Carburizing, nitriding and boriding techniques.
Mechanical treatments - Cold working, Shot peening and SMAT processes and Laser peening.
Friction based - friction surfacing and friction stir processing techniques.
Hard facing - selection of hard facing materials and techniques. Laser cladding and laser surface alloying.
Thermal spraying techniques – Flame spraying, Oxy-fuel powder spraying, D-gun spraying, HVOF coating, Plasma spraying and Cold/kinetic spraying. Physical vapour deposition – PVD system, Thermal evaporation, Sputtering, Pulsed laser deposition, Electron beam deposition.
Chemical Vapour Deposition (CVD) – CVD system, Hot wall and Cold wall reactors, Thermally activated and Plasma assisted CVD techniques. CVD diamond – A case study.
Protective coatings for high temperature applications – Diffusion coatings, Overlay coatings, Pack cementation. Thermal Barrier Coatings (TBC) – Coating architecture, deposition

methods and applications.

Structural, microstructural and mechanical characterization techniques with focus on surface engineering.

Text Books/ Reference Books:

1. Budinski ,K.G., “Surface Engineering for Wear Resistances”, Prentice Hall, Englewood Cliffs, 1988
2. Ohring, M., “ The Materials Science of Thin Films”, Academic Press Inc, 2005
3. Morton,P.H., “Surface Engineering & Heat Treatment”, Brooke field, 1991

MEL *: ADVANCED MECHANICS OF SOLIDS**

3 credits (3-0-0)

Pre-requisites: MEL206 Solid Mechanics

Overlaps with: MEL418 Advanced Stress Analysis (10%)

Course Outcomes/ Objectives :

4. To provide students with the fundamental understanding of advanced area and applications of solid mechanics and theory of elasticity.
5. To develop analytical and mathematical modeling skill among students in the area of Solid mechanics.
6. To develop computational skill in the area of two/three dimensional stress and deflection analysis.
7. To make the students confident with actual engineering problems :

Mapping with POs:

CO/ PO	a	b	c	d	e	f	g	h	i	j	k
CO1	H	H	H	H	H	M	M	H	H	H	H
CO2	H	H	M	M	H	M	M	H	M	H	H
CO3	M	L	M	H	H	M	M	L	L	H	H
CO4	H	M	H	M	H	M	M	L	L	M	H
Overall	H	H	M	M	H	M	M	H	M	H	H

Course Content:

Unit 1: Bending of straight beams

Deflections in statically determinate and indeterminate beams. Energy method and application of Castiglianos theorem. Maxwell-Betti reciprocal theorem. Influence functions (Green's functions) for beams. Beams on elastic foundations.

Unit 2: Bending of curved beam (Winkler-Bach formula).

In-plane and out of plane loaded curved beams. Applications in helical springs, crane hooks etc.

Unit 3: Stresses in cylindrical discs.

Rotating discs and discs with pressure and shrink fits.Thick walled cylinder subjected to internal and external pressure.

Unit 4: Bending of Plates

Differential equation of plate bending under small defelection. Rectangular and circular plates with various boundary conditions. Navier solution for simply supported and uniformly loaded rectangular plates. Plates under hydrostatic pressure and under concentrated loading. Equation of bending of plates in polar co ordinate. Axisymmetric bending of circular plate under various loading conditions. Solutions using Greens functions.

Unit 6: Two-dimensional problems in elasticity.

Equilibrium equations. Strain-displacement and compatibility relations. Biharmonic equation. Plane stress and plane strain problems. Stress functions approach. Airy's stress function. Polynomial function approach.

Text Books/ Reference Books

1. Theory of Elasticity by Timoshenko and Goodier. McGraw Hill publications 3rd Edition
2. Advanced Mechanics of Solids by L S Srinath Tata McGraw Hill 1st Ediiton
3. Advanced Mechanics of Materials by Solecki and Conant Oxford University Press
4. Theory of Plates and Shells by Timoshenko and Woinowsky-Krieger McGraw Hill 3rd Edition

VIII Semester

MED402PROJECT PHASE-II
4 credits

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

MEL426 REFRIGERATION & CRYOGENICS

3credits (3-0-0)

Pre-requisites: Nil

Overlaps with: Nil

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

1. Understand, conceptualize and analyze simple and multistage vapour compression refrigeration systems and cryogenic systems.
2. Understand, conceptualize and analyze alternate refrigeration systems like steam jet/vapour absorption/thermoelectric/vortex tube/air cycle refrigeration.
3. Understand functions and working of various components of refrigeration machine and types of refrigerants used.
4. Understand and solve numericals related to vapour compression, multistage and Air cycle refrigeration systems.

Mapping with POs:

POs →	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**

COs ↓											
CO1	H	H	L	-	H	M	M	M	L	H	H
CO2	H	H	M	L	M	M	M	M	L	M	H
CO3	M	M	M	-	L	M	M	M	L	M	H
CO4	H	M	M	M	H	M	M	M	L	M	M
Overall	H	H	M	L	H	M	M	M	L	M	H

Content:

1. **Vapor Compression Refrigeration System:** Introduction to refrigeration, applications of refrigeration, development of simple saturated Vapour compression refrigeration cycle, effect of change in evaporator and condenser pressure, effect of pressure drops, polytropic compression, methods of improvement in the performance of the cycle like sub cooling, superheating, use of heat exchanger etc. **CO1,CO4**

2. **Components of Vapor Compression Refrigeration System and Refrigerants**: Classification, construction and application of various components used in refrigeration technology like compressors, condensers, evaporators, expansion devices, controls, cooling towers etc. Refrigerants:Types and classification, properties and nomenclature, Azeotropes and alternate environment friendly refrigerants. **CO3**

3. **Alternate Refrigeration Systems:** Vapor absorption systems (NH_3- H_20, LiBr- H_2O,Three fluid), Steam jet refrigeration systems, Thermoelectric refrigeration, Vortex tube refrigeration. **CO2**

4. **Multistage Refrigeration Systems:** Working and analysis of multistage systems, multi-evaporator, multi-compressor vapour compression systems. **CO1, CO4**

5. **Gas Cycle Refrigeration:** Reversed Brayton /Joules/Bell Coleman cycle, aircraft refrigeration, simple, boot strap, reduced ambient and regenerative cycle. **CO2,CO4**

6. **Cryogenics:** Introduction and applications of cryogenics, cascade refrigeration, Joules Thomson coefficient, methods of air liquefaction, Linde's and Claude's cycle, adiabatic demagnetization, cryogenic insulation. **CO1**

Text Books/ Reference Books:

1. C.P. Arora , 'Refrigeration and air conditioning ',Tata Mcgraw Hill,Third edition,2016
2. P.L Ballaney, ' Refrigeration and air conditioning',Khanna Publishers, 16th edition,2013
3. S. Domkundwar, 'A course in Refrigeration and Air conditioning', Dhanpatrai publication,1980
4. P N Ananthanarayanan , 'Basic Refrigeration and Air Conditioning', McGraw Hill,Fourth edition,2013
5. Roy J Dossat, 'Principles of Refrigeration' Pearson Education', fourth edition,2009
6. Randall F Barron, 'Cryogenic systems', Oxford university press', Tata McGraw Hill, 1985.
7. ASHRAE Handbook: Fundamentals,2017
8. ASHRAE handbook –HVAC systems and Equipment
9. Carriers Handbook of Air conditioning system design

MEP426 REFRIGERATION AND CRYOGENICS

1 credits (0-0-2)

Pre-requisites: Nil

Overlaps with: Nil

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

1. understand various theoretical and practical concepts related to single stage refrigeration and for alternate refrigeration systems like , vortex tube and thermoelectric refrigeration to meet UG level requirement.
2. understand practical application of concepts of psychrometrics / psychrometric processes to actual air conditioning machine to meet UG level requirement.

3. Understand working of various equipments/systems used in refrigeration and air conditioning like compressors, condensers, evaporators, expansion devices, controls, refrigerator, air conditioner etc. from under graduate perspective.

4. Understand and apply mathematical treatment to energy efficiency calculations for refrigeration and air conditioning machines to reasonable correctness.

Mapping with POs*:

Relationship of Course Objectives to Program outcomes:

POs → COs ↓	**a**	**b**	**c**	**D**	**e**	**f**	**g**	**h**	**i**	**j**	**K**
CO1	H	H	H	M	H	M	H	M	M	M	H
CO2	H	H	H	M	H	M	H	M	M	M	H
CO3	H	H	H	M	H	M	H	M	M	M	H
CO4	H	H	H	M	H	M	H	M	M	M	H
Overall	H	H	H	M	H	M	H	M	M	M	H

Content:

1. Experiment on Determination of COP of Refrigeration trainer- **CO1, CO4**
2. Experiment on Determination of COP of Heat pump- **CO1, CO4**
3. Experiment on Determination of COP of Refrigerator- **CO1, CO4**
4. Experiment on Determination of COP of Thermoelectric Refrigeration- **CO1, CO4**
5. Experiment on Determination of COP of Room air conditioner-**CO2,CO4**
6. Demonstration of frost free refrigerator-**CO3**
7. Demonstration of conventional Refrigerator-**CO3**

8. Study and demonstration of types of compressors-**CO3**
9. Study and demonstration of types of condensers-**CO3**
10. Study and demonstration of types of evaporators-**CO3**
11. Study and demonstration of types of expansion devices- **CO3**

Text Books/ Reference Books:

1. C.P. Arora , 'Refrigeration and air conditioning ',Tata Mcgraw Hill,Third edition,2016

2. P N Ananthanarayanan , 'Basic Refrigeration and Air Conditioning', McGraw Hill,Fourth edition,2013

3. AHRAE handbook –HVAC systems and Equipment

MEL430 ADVANCED IC ENGINES

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : **:** On completion of this course, students will be

1. Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle
2. Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance
3. To Demonstrate the delay period and fuel injection system

Content:

Introduction

Engines types and their operation, Introduction and Historical Perspective, Engine classifications, Engine operating cycles, Engine components, Engine friction, lubrication and

cooling, lubrication systems. Frictional losses, blow by losses, pumping loss, Factors affecting mechanical friction

Fuels

Fluid, Solid, gaseous, liquid fuels, SI Engine fuels characteristics, C.I. Engine fuels, characteristics, Rating of engine fuels, I.C. engine fuels - petrol, diesel ENG, LPG, Alcohol, Vegetable oils, Combustion, Combustion stoichiometry - The first low of thermodynamics and combustion, Enthalpies of formation, Heating values combustion efficiency. The second law of thermodynamics applied to combustions. Maximum work, chemical equilibrium, theoretical flame temperature.

SI Engine

S. I. Engine fuel requirements, carburetors, factors attesting carburetion, moderns carburetors, metering systems, choke, altitude compensation, fuel injection systems, multipoint port injection, feedback systems, charge motion within the cylinder swirl, squish, combustion stages, flame propagation cyclic variations in combustion, ignition fundamentals, conventional ignition system, abnormal combustion, knock and surface ignition, knock fundamentals, turbo charging, supercharging and scavenging in engines.

C. I. Engines

Essential features of the process, combustion systems. Combustion in direct and indirect injection, fuel spray behavior. Fuel injection systems, fuel pumps, fuel injectors, atomization, combustion in C. I. Engines, ignition delay, certain number, auto ignition. Factors affecting delay. Effects of fuel properties. Abnormal combustion, supercharging and turbo charging in engines.

Pollutant formation & Control

Nature and extent of problem, Nitrogen oxides Kinetics of NO formation, formation of NO2 NO formation in S. I. Engines NOx formation in C. I. Engine Carbon monoxide and unearned hydrocarbon emissions in S.I. and C.I. engines, EGR Particulate emissions, measurement technique. Catalytic converters, particulate traps.

Engine Design and Operating Parameters

Important engine characteristics, Geometrical properties of Reciprocating engines, Brake,

Torque & Power, Indicated work per cycle, Mechanical efficiency, Road load power, Mean effective pressure, Specific fuel consumption and efficiency, Air/Fuel and Fuel/Air ratios, Volumetric efficiency, Engine specific weight and specific volume, Correction factors for power and efficiency, Specific emission and emission index, Relationship between performance parameters

Measurement and Testing

Measurement of friction 'power indicated power, Brake power, Fuel consumption, Air consumption, Performance parameters and characteristics: Engine Power, Engine efficiencies, Engine performance characteristics, Variables affecting performance characteristics

Text Books/ Reference Books:

1. Heywood J.B., "Internal Combustion Engine Fundamentals", McGraw Hill 1988
2. Obert E.F., "Internal Combustion Engines and Air pollution", Intext Educational Pub 1974
3. Ganesan, V., "Internal Combustion Engines", Tata McGraw Hill Publishing Co. 6th Ed
4. Domkundwar, V.M., "Internal Combustion Engines"
5. Mathur, M.C., Sharma, R. D., "Internal Combustion Engines", DhanpatRai Pub 8th Ed 2003

MEP430ADV. I.C. ENGINE

1 credits (0-0-2)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives **::** On completion of this course, students will be

1. Understand the current available engines, their operating principles and their characteristics
2. Be able to test the performance of engines

Content:

1. Study of Carburetors

2. Study of Fuel Injection Systems
3. Study of Engine Components
4. Performance Characteristics of C.I. Engine
5. Performance Characteristics of C.I. Engine
6. Experiment on Air Pollution

Text Books/ Reference Books

MEL445 AUTOMATION IN PRODUCTION
3 credits (3-0-0)

Pre-requisites: NIL
Overlaps with:
Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

MEP445 AUTOMATION IN PRODUCTION
1 credits (0-0-2)

Pre-requisites: NIL
Overlaps with:
Course Outcomes/ Objectives :

Content:

Text Books/ Reference Books:

MEL443AIR POLLUTION CONTROL
3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives:

1. After attending the course the students shall have acquired knowledge and understanding to evaluate air quality management and analyze the causes and effects of air pollution.Students would be able to understand the type and nature of air pollutants, the behavior of plumes and relevant meteorological determinants influencing the dispersion of air pollutants.

Content:

Introduction
Conventional energy conversion methods using fossil fuels. Their environmental aspects, Pollution from the thermal power plants, thermal and particulate pollution and its control.
IC Engines
Combustion in petrol and diesel engines. Emissions from I.C. Engines and its control. Primary and Secondary Pollutants. Use of various alternative fuels, additives and their effect on pollution.
Conventional and microprocessor based control of Air/Fuel ratio, ignition and injection timing, speed and emissions from I. C. Engines.
Noise pollution
Noise pollution and noise control. Standardization for environmental control pollution

Text Books/ Reference Books:

1. Rao, "Air Pollution", Tata McGraw Hill, 7th Edition, 2001
2. Obert E.F., "IC Engines and Air Pollution" , Harper & Row Pub, 1979
3. Reston, "Automotive Pollution Control", Reston Pub Co1984
4. Prabhakar V.K , "Air Pollution Monitoring and Control", AnmolPrakashan, 1st Edition, 2001

MEL449 ADVANCED TURBO MACHINERY

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

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

1. Use dimensional Analysis to compare homologous Machines

2. Classify and explain the function of dimensionless number
3. Design Prototype from Model
4. Select Fluid Machines for Appropriate Operations
5. Explain the Applications of Thermodynamics Laws.
6. Design both positive Displacement and Rotor dynamic Fluid Machines

Content:

Machinery, dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency.

Centrifugal fans and blowers: Types, stage and design parameters, flow analysis in impeller blades-volute and diffusers, losses, characteristic curves and selection, fan drives and fan noise.

Centrifugal Compressor: Construction details, impeller flow losses, slip factor, diffuser analysis, losses and performance curves.

Axial flow compressor: Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, stage design problems and performance characteristics.

Axial and radial flow turbines: Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics.

CFD for Turbo machinery, General Aspects.

Text Books/ Reference Books:

1. Yahya, S.H., "Turbines Compressors and Fans", Tata McGraw-Hill Publishing Company, 1996
2. Earl Logan, Jr., "Hand book of Turbomachinery", Marcel Dekker Inc, 1992
3. Dixon, S.I., "Fluid Mechanics and Thermodynamics of Turbomachinery", Pergamon Press, 1990
4. Shepherd, D.G, "Principles of Turbomachinery", Macmillan, 1969.

MEL401 CONTROL SYSTEMS

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : On completion of this course, students will be

1. Demonstrate an understanding of the fundamentals of (feedback) control systems.
2. Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.
3. Express and solve system equations in state-variable form (state variable models).
4. Determine the time and frequency-domain responses of first and second-order systems to step and sinusoidal (and to some extent, ramp) inputs.
5. Determine the (absolute) stability of a closed-loop control system
6. Apply root-locus technique to analyze and design control systems.

Content:

Principal of feedback control: Types of control system and error constants. Performance characterization of second and higher order systems through transient response. Effect of additional zero and pole. Introduction to design and compensation.

Compensator design: Compensator design using root locus plot. Cascade lag compensation, cascade lead compensation. Lag-lead compensation. Root locus of system with dead time and sensitivity analysis. Compensator design using Bode plots.

Controllers : PID controllers Pneumatic valves, actuator and controllers. Hydraulic actuators and servo mechanisms. DC Servo motor and stepper motors. Control through operational amplifiers.

Control Systems :State variable, modeling of control system. Conversion of state variable model to transfer function and vice versa. Solution of state equations. State transition matrix. Concepts of controllability and observability.

Introduction to digital control systems :Sample data systems, Z transform of discrete signals. Performance of a sample data second order system. Root locus of digital control systems. Stability analysis in the Z plane.

Introduction to control system on MATLAB platform

Introduction to control system on MATLAB platform. MATLAB commands and control system toolbox. Analysis of transient response of control system through MATLAB commands. Root locus and BODE plot on MATLAB figure window. Simulation of digital control system using MATLAB.

Text Books/ Reference Books:

1. Nise, “Control system Engineering”, Wiley, 1995
2. Dorf, “Modern control system”, Addison Wesley, 8th Ed 199
3. Gopal, “Digital control system”, Tata McGraw Hill, New Delhi
4. Ogata, K., “Modern Control Engineering”, Prentice Hall of India, Third Edition

MEL424 INDUSTRIAL ENGINEERING & MANAGEMENT

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with: NIL

Course Outcomes/ Objectives :On completion of this course, students will be

1. Student can answer/solve questions/quizzes/case studies related to principles of management.
2. Student can answer/solve questions/quizzes/case studies related to personal management.
3. Student can answer/solve questions/quizzes/case studies related to plant management.
4. Student can answer/solve questions/quizzes/case studies related to marketing management.
5. Student can answer/solve questions/quizzes/case studies related to materials management.
6. Student can answer/solve questions/quizzes/case studies related to financial management.

Mapping with POs

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	L	--	M	--	--	H	H	M	H	L	M
CO2	L	--	M	--	L	H	H	M	H	L	M
CO3	M	M	M	--	M	H	H	M	H	M	M
CO4	L	M	M	--	M	H	H	M	H	L	M
CO5	M	M	M	--	M	H	H	M	H	M	M

CO6	L	M	M	--	M	H	H	M	H	L	M
Overall	L	M	M	--	M	H	H	M	H	L	M

Content:

Principles of management : Concepts of management, development of scientific management, principles of Fredric Taylor & functions such as planning organizing, staffing, leading motivating, communicating, controlling, decision making, span of control

Personal management: Meaning, functions of personal management, manpower planning, collective bargaining, wages & salary administration, labor welfare, training, trade unions, industrial factories Act, industrial boilers Act, Trade union act.

Plant management : Plant location, plant layout, types of maintenance such as break down, predictive & preventive maintenance, stores of management, industrial safety, causes & cost of accidents, safety programs, production planning & control, job, batch & process type of production

Marketing management : Definition & selling & modern concept of marketing, market research, new product development, product life cycle product launching, sales promotion, pricing, channels of distribution, advertising, market segmentation, marketing mix.

Material management : Importance of material management, classification, codification, forecasting, necessity of inventory

Financial management : Sources of finance, financing organizations, types of capital, elements of costs & allocation of indirect expenses, cost control, break even analysis, budgets & budgetary control, equipment replacement policy, make or buy analysis, balance sheet, ratio analysis, profit & loss statement.

Text Books/ Reference Books:

1. Koontz, O Daniall “Principles of management”.
2. Kuchal S.C “Financial management” Chaitanya Publishing House, 1996.
3. Banga T.R. Sharma S.C “Industrial organization & engineering Economics”, Khanna Pub.
4. Kotler P., Stauton William. “Principles of marketing management”, 5th Ed., Prentice Hall, 1985.

MEL428 MACHINE TOOL DESIGN

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with: NIL

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

1. Explain basic systems in machine tools and principles of their design
2. Select appropriate design criteria for machine tool elements
3. Design basic systems in machine tools
4. Select testing procedures and standards for machine tools

Mapping with POs:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	H	L	M	---	L	L	M	L	H	M	H
CO2	H	H	H	M	H	M	M	L	H	H	H
CO3	H	H	H	M	H	H	M	L	H	H	H
CO4	H	M	L	L	L	H	H	L	H	H	H
Overall	H	H	H	M	M	H	M	L	H	H	H

Content:

Principles of machine tool design,

Design of machine tool structures, (CO1, CO2, CO3)

Regulation of speeds and feeds. Design of speed, feed and spindle drives / gearboxes. (CO1, CO2, CO3)

Design of spindles and spindle supports, (CO1, CO2, CO3)

Design of Guide ways, (CO1, CO2, CO3)

Machine tool dynamics and vibration behavior, (CO1, CO2, CO3)

Control systems in machine tools,

Testing of machine tools.(CO4)

Text Books/ Reference Books:

1. Mehta N. K “Machine Tool design and Numerical Control” Tata McGraw Hill 6th Edition 2006.
2. Basu S. K. and Pal D. K., “Design of Machine Tools”, Oxford and IBH Publishing Company Pvt. Ltd. New Delhi, Fifth Edition 2011.
3. Nicholas Lisitsyn, Alexis V. Kudryashov and Oleg Trifonov “Machine Tool Design” University Press of the Pacific Paperback 4th Edition 2000.
4. Boothroyd G. and Knight W. A. “Fundamentals of Machining and Machine Tools”CRC Press, Taylor and Francis, New Delhi 3rd Edition 2006
5. Jain K. C. and Chitale A. K. “A Text Book of Production Engineering”Prentice Hall India, New Delhi 2010

MEL403 OPERATIONS RESEARCH

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

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

1. recognize the importance and value of Operations Research and mathematical modeling in solving practical problems in industry;
2. formulate a managerial decision problem into a mathematical model;
3. understand Operations Research models and apply them to real-life problems;
4. Use computer tools to solve a mathematical model for a practical problem.

Content:

Introduction to OR& basic OR models, definition, characteristics and limitations of OR, linear programming: solutions of LPP by graphical method and simplex method, formulation of dual of LPP.

Assignment model, travelling salesman problem by, Transportation Problems, transshipment model.

Dynamic programming, structure and characteristics of dynamic programming, application of dynamic programming to resource allocation, inventory control & linear programming.

Project management: drawing of network, CPM & PERT, Probability of completion of project, cost analysis of project, allocation and updating of networks. .

Replacement models: concept of equivalent, interest rate, present worth, economic evaluation of alternatives, group replacement models. Inventory control models, analysis of single product deterministic models.

Waiting line situations, queuing theory and models (no derivations expected). Simulation concept and its application in waiting line situations, inventory and networks

Text Books/ Reference Books:

1. Mohan, C. and Deep, Kusum: "Optimization Techniques", New Age, 2009.
2. Mittal, K. V. and Mohan, C. "Optimization Methods in Operations Research and Systems Analysis", New Age, 2003.
3. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
4. Ravindran, A., Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
5. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
6. Chandra, Suresh, Jayadeva and Mehra, Aparna, "Numerical Optimization with Applications", Narosa, 2009.

MEL448ARTIFICIAL INTELLIGENCE IN MANUFACTURING

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

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

1. Explain importance of artificial intelligence techniques used in manufacturing engineering
2. Implement machine learning techniques to engineering problems
3. Design fuzzy control system, evolutionary systems and nature inspired learning systems for manufacturing engineering problems.

Mapping with POs:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	H	L	M	M	H	-	-	-	L	M	-
CO2	H	H	M	L	H	-	-	M	H	M	-
CO3	H	M	M	L	H	-	-	-	L	M	-
Overall	H	M	M	L	H	-	-	M	M	M	-

Content:

Overview of artificial intelligence: Introduction to AI, evolution of AI, application areas, advantages, limitations, future applications. (CO1)

Knowledge base expert systems: Introduction, expert system components and human interfaces, expert system characteristics and features, knowledge acquisition, knowledge base, inference engine, forward chaining, backward chaining, expert system shell, explanation. (CO1)

Fuzzy logic: Introduction, Sources of Uncertainty, Membership Functions and Uncertainty, type I and II fuzzy logic systems, application of fuzzy logic to manufacturing engineering problems. (CO3)

Genetic algorithms: Introduction, random heuristic search, simple genetic algorithm (SGA): algebra, selection, mutation, crossover, mixing, application of SGA for solving single objective multi constraint problems. (CO3)

Artificial neural networks: Introduction, supervised and unsupervised neural networks, single and multilayered neural networks, applications, advantages, drawbacks. (CO2)

Introduction to Fusion of ANN, fuzzy and GA. (CO3)

Case studies: Based on total number of students opting for this course will be grouped and asked to select problems from manufacturing engineering to solve them using learned techniques.

1. Learning of expert system software like VIDWAN, CLIPS and its application to make a

decision support system to solve manufacturing engineering problems like, selection of tool characteristics based on application, selection of manufacturing systems, fault diagnostics for vehicles and advance machines.

2. Application of fuzzy logic for selection of layered manufacturing systems, fluid flow control and temperature control systems
3. Application of GA for solving scheduling and cellular manufacturing
4. Modeling and application of ANN to manufacturing problems like optimal parameter selection for drilling, milling, EDM etc.

Text Books/ Reference Books:

1. Rajashekaran, S. and Pai, GAV, "Neural Networks, Fuzzy logic & G. A. Synthesis & Application", PHI, 1st Edition, 2012.
2. K. Deb, "Genetic Algorithms", Wiley, 2010.
3. David E Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning ", Pearson Education India.
4. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", John Wiley Publication.
5. Satish Kumar, "Neural Networks: A Classroom Approach", Tata McGraw-Hill Education.

MEL413 FRACTURE MECHANICS

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : On completion of this course,

1. Student will have knowledge of basic crack growth mechanism.
2. Student will select proper design based on fracture mechanics.
3. Student will be able to estimate the safe life design product.
4. Students will be able to get the knowledge of different NDT testing.

Content:

Introduction to Fracture Mechanics: Introduction to the realm of fracture and back ground history of development of fracture mechanics; Discrepancy between theoretical and real

strength of materials, conventional failure criteria based on stress concentration and characteristic brittle failures, Griffith's work.

Linear Elastic Fracture Mechanics (LEFM): Crack deformation modes and basic concepts, crack tip stresses and deformation, Stress Intensity Factor (SIF) and its criticality in different modes, superposition of SIFs, LEFM design concept applications; Concept of energy release rate, equivalence of energy release rate and SIF.

Fracture toughness and its laboratory determination procedure, test specimen size requirement etc.; Effect of temperature and loading rate on fracture toughness; Fatigue and fatigue crack propagation laws, fatigue life calculations under constant and variable amplitude loading, mixed-mode fatigue crack propagation

Elastic Plastic Fracture Mechanics (EPFM): Design criteria for non-brittle materials; plastic zone corrections, crack opening displacement (COD), J-contour integral and crack growth resistance (R-curve) concepts.

Text Books/ Reference Books:

1. P.Kumar, "Elements of Fracture Mechanics", McGraw Hill, 2012.
2. M. Jansen, J. Zuidema, R. Wanhill, "Fracture Mechanics" Spon Press, 2004.
3. T.L. Anderson, "Fracture Mechanics: - Fundamentals and Application", Taylor and Francis, 2005.
4. R.W. Hetzberg, "Deformation and fracture mechanics of engineering material", John wiley and son, 1996.

MEL454 QUALITY ENGINEERING MANAGEMENT

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

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

1. Implement the concepts and philosophies in quality engineering and management and underlying statistical theories to engineering problems.
2. Develop analytical skills for investigating the quality related problems by adopting

appropriate analytical/ statistical tools and techniques.

3. Practice Robust design through processes analysis and improvement.
4. Build an aptitude for solving quality and reliability related issues through case studies, mini projects and use of appropriate software.

Content:

Evolution of quality concept, Meaning and dimensions of quality, Quality philosophies, Process quality improvement methodologies, like, TQM, Quality Management System & ISO, Six Sigma, SQC, SPC, BPR, BPM, JIT, Lean, etc.

Understanding the value chain, Customer's perception of quality, Kano model, Zone of tolerance, Statistical concepts in quality management, Quality improvement/management tools and techniques, Control charts, Acceptance sampling, Process capability analysis, FMEA, Use of simulation in quality, Service quality, Quality costs, Digital value chain and role of quality engineering and management in digital value chain.

Robust design, Taguchi techniques, Loss function, Orthogonal Arrays, Design of experiments, ANOVA, System reliability and failure analysis.

Multicriteria techniques in quality management, Introduction to National & International Quality Awards.

Mini projects, case studies, individual or group exercises, and use of appropriate software

Text Books/ Reference Books:

1. Mitra, A., " Fundamentals of Quality Control and Improvement", 2008, Prentice Hall.
2. Ryan, Thomas, "Statistical Methods for Quality Improvement," 2011, John Wiley & Sons.
3. Dhillon, B. S., "Applied Reliability and Quality," 2007, Springer.
4. Phadke, M. S., " Quality Engineering using Robust Design," 1989, Prentice Hall

MEL418 ADVANCED STRESS ANALYSIS

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : After completion of this course, student will be able to

i. Explain the concept of elasticity, and the difference between stress and strain
ii. Explain the terms: isotropic, orthotropic and anisotropic, as applied to materials
iii. Explain the terms: plane stress and plane strain
iv. Use the concepts of principal stress and principal strains. Use the basic tensor notations, the stress, strain and inertia tensors, and their reduction to principal axes
v. Apply the analytical procedures involved in strain gauge measurements, in particular the transformation equations. Solve basic problems in two-dimensional elasticity using Airy's stress function

Mapping with POs:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	H	M	H	H	H	-	-	-	H	H	H
CO2	H	H	H	H	M	-	-	-	H	H	H
CO3	H	L	L	M	H	-	-	-	H	M	H
CO4	H	L	M	M	L	-	-	-	H	H	M
CO5	H	H	H	H	H	-	-	-	M	H	H
CO6	H	H	H	M	H	-	-	-	M	H	H
CO7	M	H	H	M	H	-	-	-	H	M	H
Overall	H	H	H	M	H	-	-	-	H	H	H

Content:

Fundamentals of stress and strain, stress strain relationship, Elastic constant, plane stress,

plane strain: CO1, CO2 and CO3

Stress analysis for two-dimensional problems in Cartesian coordinate system, differential equations of equilibrium. Boundary conditions, compatibility equation, Airy's stress function: CO4, CO5

Two dimensional problems in polar coordinate systems, general equations in polar coordinate systems, general equations in polar coordinates, stress distribution about systematic axis. Pure bending of curved beams, effect of hole on stress distribution in plates: CO4 and CO5

Thermal stress, circular disc, thin plate, long cylinder: CO3, CO4

Photo elasticity Introduction, polarized light, wave plates, plane and circular poloriscope, Isochromatic & isoclinic fringes, compensation techniques, separation techniques, analysis of fringe patterns. Introduction to 3-D photo elasticity: CO5

Strain Gauge techniques, strain gauge circuit, recording instruments, analysis of data, strain rosette. Brittle coating technique, coating stress, failure theories, crack patterns, crack detection, Moire fringe techniques: CO4, CO5

Text Books/ Reference Books:

1. Timoshnko, Goodiar, "Theory of Elasticity", McGraw Hill Book Co., 3rd Edition, 1970
2. Dalley, Rille, "Experimental Stress Analysis", McGraw Hill Book Co., 3rd Edition, 1991
3. Dove, Adams, "Experimental Stress Analysis," Prentice Hall of India, 1965

MEL405 OPTIMIZATION

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : On completion of this course,

1. Students will be able to apply knowledge of classical optimization techniques to solve the problems of mechanical systems.
2. Students will be able to apply knowledge of numerical methods for solving the constrained and unconstrained problems of mechanical engineering.

Students will be able formulate the mathematical model for a system operating under some constraints and be able to write own codes in matlab for the optimization of the system response.

Content:

Introduction to Optimization Techniques, Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function –objective function surfaces – classification of Optimization problems, Graphical Method.

Classical Optimization Techniques. Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable, Optimization with equality constraints. Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints. Kuhn-Tucker Conditions, Constraint Qualification.

Unconstrained optimization Techniques, Introduction; Standard form of the problem and basic terminology; Direct search method- Simplex method, Random search method, Univariate and pattern search method, Indirect search method-Steepest Descent (Cauchy) method, Conjugate gradient method, Newton's method, Application to engineering problems.

Constrained Optimization Introduction; Standard form of the problem and basic terminology; Direct method; Linear Programming (Simplex) ; Sequential Linear Programming; Generalized reduced gradient method, Methods of feasible direction Indirect method: Penalty function method, Interior and exterior penalty function method, Convex programming problem, Check for Convergence. Application to engineering problems Introduction to non-traditional methods, Genetic Algorithm: Introduction, Representation of design variables, Objective function and constraints, Genetic operators and numerical results. Introduction to Neural network based optimization.

Text Books/ Reference Books:

1. Rao, S. S., "Engineering Optimization (Theory and Practice)", John Wiley & Sons
2. Arora, Jasbir S. , "Introduction to Optimum Design", Elsevier Academic Press
3. Deb, K., "Optimization for Engineering Design-Algorithms and Examples", PHI Learning Private Limited, New Delhi

MEL444 SOLAR ENERGY UTILIZATION

3 credits (3-0-0)

Pre-requisites: Heat transfer and Fluid mechanics

Overlaps with: Renewal Energy Sources

Course Outcomes/ Objectives :

After completion of this course, student will be able to

1. learn the fundamentals of geometry of solar radiation
2. performance analysis of solar thermal systems
3. analyze the basics of renewal sources of energy

Mapping with POs:

POs → / COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	H	H	L	H	H	H	H	M	H	L	L
CO2	L	L	M	M	H	M	M	M	L	L	M
CO3	L	M	L	H	H	M	L	L	L	L	M
Overall	M	M	L	M	H	L	M	M	L	L	L

Content:

Geometry of solar radiation [1]
Solar Thermal systems such as liquid flat plate collector, air heater and concentrating collector, Solar pond, Solar distillation, Solar drying. Thermal storage. Modelling of above systems, Steady state and transient analysis, simulation in process design. [1,2]
Design and performance analysis of PV systems [1,2]
Different sources of renewal energy: Need for alternative sources of energy, various options available, principles of energy conversion using solar energy, wind energy, Ocean energy, Geothermal energy and MHD power generation [1,3]

Text Books/ Reference Books:

4. Sukhatme S.P , “Solar energy,” Tata McGraw Hill, 2nd Ed 2003
5. Duffie, Beckman, “Solar energy”, John Wiley & Sons, 1974
6. Parulekar B.B., Rao S, “Energy technology”, Khanna Publishers, 3rd Ed 1995

MEL446 PRODUCT DESIGN

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :Upon completing this course,

1. The student will be able to understand various definitions and theoretical concepts related to product design to interdisciplinary UG level students.
2. The students will be able to analyze the concepts and philosophies of product design based on requirement and other inputs form market, cost, manufacturing, product up gradation and creativity.
3. The students will be able to comprehend engineering knowledge, art viewpoint in product design and functionality aspect towards sustainable product lifecycle
4. The students will be able to apply of above objectives for product analysis through case studies

Mapping with POs*:

POs → COs ↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**
CO1	H	-	L	-	-	H	H	-	H	M
CO2	L	-	M	-	-	M	M	-	M	H
CO3	L	-	M	-	-	L	M	-	H	M
CO4	H	-	M	-	-	M	M	-	H	M
Overall	M	-	M	-	-	M	M	-	H	M

Content:

Characteristics of successful product Development, Design Definitions and Design Spectrum, Challenges and creativity in product development, Design and development cycle, Generic development process. (CO1)

Product Planning, Need for design and development in product, Product Specifications, Concept Generation, Concept Selection, product Attributes, Concept Testing, Product

Architecture.(CO1, CO2)

Industrial Design, constraint of Manufacturing Methods in Product design, Model realization, Prototyping, Robust Design, Materials in Product Design, Methods of material, shape and process selections.(CO1,CO2)

Design for quality and reliability, Approach towards robust design, Product Development Economics, IPR and commerce issues in product design. (CO3,CO4)

Design Philosophies, Product Attributes, Function and Emotion, Product configurations and Component relationships (component Matrix), Design Research, Product Analysis Diachronic, Synchronic Understanding and Analyzing contexts, parallel situations, future situations, Understanding modularity and modular systems, 3D lattice and structures Design of Modular System abstract design, Process of conception and its documentation.(CO4)

Sustainability issue in Design, Product design for environment, Product life cycle, case studies of Failures in product design, Product design for customer's requirements product(CO4)

Text Books/ Reference Books:

1. Product design and development by Karl T. Ulrich and Steven D. Eppinger, McGraw-Hill, 5th Edition
2. Product planning and Management by William l Moore and E. A. Pressemier McGraw-Hill International edition 2nd Edition
3. Engineering design methods strategies for product design, Nigel Cross, Willey Publication

MEL447 ENGINEERING ECONOMICS

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives : Upon completing this course,

1. Shall be able to take decision based on economic analysis for selecting projects.
2. Shall be able to take decision based on economic analysis for replacement.
3. Shall be able to take decision based on after tax analysis.
4. Shall be able to take decision with limited capital.

Mapping with POs:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	M	M	-	M	-	H	H	H	H	L	M
CO2	M	M	-	M	-	H	H	H	H	L	M
CO3	M	M	-	M	-	H	H	H	H	L	M
CO4	M	M	-	M	-	H	H	H	H	L	M
Overall	M	M	-	M	-	H	H	H	H	L	M

Content:

Introduction to Engineering Economics as a tool of decision making, Basic Concepts of interestand time value of money. Factors & Their Use, Nominal & Effective Interest Rates, Use of MultipleFactors. Selection of alternatives using Present Worth, Annual Worth. RoRComputation,RoREvaluation, Multiple RoR. Use of RoR for selection of alternatives. Incremental analysis.

Benefit Cost Ratio, Modified Benefit Cost Ratio and selection of projects using Benefit Cost Ratio as a parameter. ----- CO1

Replacement Analysis: Choice of alternatives for replacement of old equipment using

different techniques including one more year technique. Activity based costing. ---- CO2

Various types of Bonds, Shares and other Financial Instruments; calculation of RoR under different situations. Inflation, effect of inflation on actual rate of interest and actual RoR.

Determination of cost of project in future.

Depreciation: Various techniques of calculating depreciation and its effect on Present Worth.

Depletion and its estimation.

Income Tax, After Tax Economic Analysis, Determination RoR before and after Income Tax. Breakeven Analysis. ----- CO3

Capital Rationing and choice of combination of alternatives.Influenceof various economic conditions on Minimum Attractive Rate of Return and its determination. Sensitivity Analysis. ------- CO4

Text Books/ Reference Books:

1. Engineering Economy; L T Blank, A J Torquin, McGraw Hill, 7th Edition
2. Engineering Economy; W G Sullivan, E M Wicks, Pearson Education,16th Edition

MEL 455 Value Engineering

3 credits (3-0-0)

Pre-requisites: Nil

Overlaps with:

Course Outcomes/ Objectives:

1) To explain students what is a value engineering
2) To make student understand various definitions and theoretical concepts related to value engineering UG and PG level students.
3) To explain student the value engineering strategies and subsequent steps to manifest conceptualised problems in value engineering.

Content:

Introduction, Value, Function – Types of functions, Level of function, Function identification, method of finding the function of a product, case history /case study

Cost, cost and price, elements of cost, need to calculate cost, Cost evaluation, case study methods of determining the cost

Worth, Evaluation of worth, guidelines to find out worth, Importance of worth in the value engineering, metrology, discussion on worth.

Techniques – Brainstorming, The Gordon technique, Feasibility Ranking, the morphological

analysis technique, ABC Analysis, probabilistic approach, Make or buy technique Special techniques, function- cost- worth Analysis, function analysis system techniques, Weighted Evaluation method, evolution matrix, Break even analysis, Life cycle cost Applications, team dynamics, team structure, team building, job plan, orientation phase, information phase, function phase creative phase, evaluation phase, recommendation phase, implementation phase, case study- detail case short case

Text Books/ Reference Books:

1. Value Engineering, Anil K. Mukhopadhyaya SAGE Publications Inc, Ist Edition, 2003, IVth printing 2013.
2. Value Engineering: Theory and Practice in Industry Thomas R. King, Publisher: CVS Lawrence D. Miles Foundation, ISBN: 0-9679217-1-6, 2000 edition.
3. Value Engineering: Analysis and Methodology Del Younker, Publisher: CCC/CVS, Winter Springs, Florida, USA ISBN: 9780824706968 Publication Date: May 14, 2003

MEL453 ENGINEERING PRODUCT DEVELOPMENT

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :Upon completing this course,

1. The students will be able to understand various definitions and theoretical concepts related to engineering product development to UG and PG level students.
2. The students will be able to apply product development strategies and subsequent steps to manifest conceptualized product idea into an engineering product.
3. The students will be able to comprehend, integrate and organize engineering knowledge, technology tools, and other resources so as to deliver commercial

engineering product.

4. The students will be able to analyze commercial engineering product with above objectives through case studies

Mapping with POs*:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j
CO1	H	-	H	-	-	H	H	-	H	M
CO2	M	-	M	-	-	M	M	-	M	M
CO3	L	-	-	-	-	M	L	-	M	L
CO4	M	-	M	-	-	M	M	-	L	L
Overall	M	-	M	-	-	M	M	-	M	L

Content:

1. Engineering Product

Engineering Product, design cycle, types of design and re-design, processing of designs for commercialization, concurrent engineering, materials, process, and other considerations in engineering products, reverse engineering, Alteration of components from considerations for Manufacturing and assembly (DFMA), Standardization in design, Redesigning of the components to suit production facilities and systems (CO1)

2. New Product Development

Concept Level, Cost v/s Time evaluation, Necessity of new products, Organizational Strategies to handle new product Development, Management Approaches towards Engineering Design, Emergence of Engineering Product Development, Market Research, Formation of cross functional Teams, Quality Function Development, Product Brief, Business Case preparation and clearance , Budget Planning, Product Costing, Roles of respective CFT members, Stakeholders' meeting, concept gate review.(CO2,CO4)

3. Generation -1

Building first generation aggregate and prototypes, Tooled up exclusive components few, in quantity and percentage wise, 3D Modelling of the components, Validation through CAE rout,

Testing and Validations in different labs, fatigue testing lab, engine testing lab etc. Testing of a) sheet metal components, b) structured components, Field testing of prototypes for identified application, Field panel review, Capturing of the issues during testing and resolution process, Generation 1 gate review.(CO2,CO4)

4. Generation -2

Corrections form generation -1, Tooled up exclusive components scaled p, Generation 2 prototypes and aggregate build, Capital budget outflow, proprietary parts treatment, pre-production approval process, manufacturing location total involvement, role of CFT members from plant, Jury panel evaluation, Progress on validation, issue on capturing and resolution process, Virtual 3D modelling of the product through virtual assembly line, Generation 2 gate review (CO3,CO4)

5. Seeding

Seeding of the product, batch size, Implementation of Quality Function Deployment, Monitoring the performance at customer end, Monitor and ensure Budget utilization, Enhanced role of customer care, Marketing, Component development, quality assurance and product development teams, Monitoring the cost v/s target, capturing the issues and resolution process, Seeding Gate review.(CO3,CO4)

Text Books/ Reference Books:

1. New product Management, Crawford and Bendetto, Irwin MCGraw Hill, 6th Edition, ISBN 978, 2010 edition
2. Product planning and Management by William l Moore and E. A. Pressemier McGraw-Hill International edition 2nd Edition, 2009
3. Engineering design methods strategies for product design, Nigel Cross, Willey Publication
4. Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw-Hill, 5th Edition, 2015 reprint.

MEL450 COST ACCOUNTING

3 credits (3-0-0)

Pre-requisites: NIL

Overlaps with:

Course Outcomes/ Objectives :Upon completing this course,

1. Shall understand different types of costs and their effect on the total and unit cost.
2. Shall be in a position to implement ABC in multiproduct system.
3. Shall be in a position to analyze budget and its variance.
4. Shall be in a position to take pricing decision and capacity planning.

Mapping with POs:

POs → COs ↓	a	b	c	d	e	f	g	h	i	j	k
CO1	M	M	-	M	-	H	H	H	H	L	M
CO2	M	M	-	M	-	H	H	H	H	L	M
CO3	M	M	-	M	-	H	H	H	H	L	M
CO4	M	M	-	M	-	H	H	H	H	L	M
Overall	M	M	-	M	-	H	H	H	H	L	M

Content:

Role of Accountant: Financial & Cost Accounting, Strategic decision, Value and Supply Chain, Accounting Guidelines, Organisational Structure

Cost Terms: Fixed and Variable Costs, Direct and Indirect Costs, Cost Drivers and Cost Behaviour Patterns

Cost Volume Profit Analysis :CVP Analysis, Breakeven and Target income, CVP for Decision and strategy ------- CO1

Job Costing: Approach for job costing, System of job costing, Various approaches for

adjustments

Activity Based Costing: Need of activity based costing, ABC systems, ABC & Department Costing, Implementation of ABC ------- CO2

Master Budget: Budgets and Budgeting cycles, Advantages and Steps to be taken for Budget, Responsibility and Controllability

Flexible Budget: Static budget and variance, Flexible budget and variance, Standard costing, Use of variance in management , Planning for Variance, ------- CO3

Operational control and performance measurement

Inventory Costing, Inventory Management

Pricing Decision, Target costing and Target pricing, Decisions under conditions of risk and uncertainty

Process Costing**,** Spoilage Rework and Scrap -------- CO4

Text Books/ Reference Books:

1. Cost Accounting; C T Horngren, S M Datar, M Rajan, Pearson,15th Edition (2015)
2. Introduction to Management Accounting; C T Horngren, G L Sundem, W O Stratton, Pearson & Prentice Hall,14th Edition (2008)
3. Management & Cost Accounting; Colin M Drury, Cengage Learning India P Ltd., 8th Edition