MECHANICAL ENGINEERING

M.TECH (COMPUTER AIDED DESIGN)

(NON-CBCS)

REGULATIONS, CURRICULUM AND SYLLABUS

(With effect from the Academic Year 2011 – 12)

PONDICHERRY UNIVERSITY

PUDUCHERRY – 605 014.

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REGULATIONS FOR POST GRADUATE (M.Tech.) PROGRAMMES IN THE DISCIPLINE OF MECHANICAL ENGINEERING (NON-CBCS)
(WITH EFFECT FROM JULY 2011)

M.Tech (Computer aided Design)

1.0 ELIGIBILITY

Candidates for admission to the first semester of the four semester M.Tech course in Mechanical Engineering with specilisation in Computer Aided Design should have passed B.E / B.Tech in Mechanical Engineering / Metallurgy / Automobile / Production and Manufacturing Engineering through regular course of study from an AICTE approved institution or an examination of any University or authority accepted by the Pondicherry University as equivalent thereto, with at least 55% marks in the degree examination or equivalent CGPA.

Note:

1. Candidates belonging to SC/ST who have a mere pass in the qualifying examination are eligible.
2. There is no age limit for M.Tech. programmes.

2.0 ADMISSION

The admission policy for various M.Tech. programmes shall be decided by the respective institutes offering M.Tech. programmes subject to conforming to the relevant regulations of the Pondicherry University.

3.0 STRUCTURE OF M.Tech. PROGRAMME

3.1 General

3.1.1. The M.Tech. Programmes are of semester pattern with 16 weeks of instruction in a semester.

3.1.2 The programme of instruction for each stream of specialisation will consist of:

i. Core courses (Compulsory)
ii. Electives
iii. Laboratory
iv. Project work

3.1.3 The M.Tech. Programmes are of 4 semester duration.

3.1.4. Credits will be assigned to the courses based on the following general pattern:

i. One credit for each lecture period
ii. One credit for each tutorial period
iii. Two credits for practical course
iv. Twenty three credits for Project work divided into 9 credits for Phase-I and 14 credits for Phase – II.
v. Three credits for directed study

One teaching period shall be of 60 minutes duration including 10 minutes for discussion and movement.

3.1.5 Regulations, curriculum and syllabus of the M.Tech. programme shall have the approval of Board of Studies and other Boards/ Committees/ Councils, prescribed by the Pondicherry University. The curriculum should be so drawn up that the minimum number of credits and other requirements for the successful completion of the programme will be as given in Table – 1.

Table 1: Minimum credits and other requirements

Sl.No.	Description	Requirements
		M.Tech (Full-Time)
1	Number of Semesters	4
2	Min. number of credits of the programme	72
3	Max. number of credits of the programme	75
4	Min. Cumulative Grade Point Average for pass	5
5	Min. successful credits needed for registering in the next semester	Sem. I: 10
		Sem. II: 25
		Sem. III: 40
6	Min. period of completion of programme (consecutive semesters)	4
7	Max. period of completion of programme(consecutive semesters)	8
8	Number of core and elective courses	13
9	Laboratory	2
10	Project work (semesters)	2

3.1.6 A core course is a course that a student admitted to the M.Tech. programme must successfully complete to receive the degree. A student shall register for all the core courses listed in the curriculum.

3.1.7 Elective courses are required to be chosen from the courses offered by the department(s) in that particular semester from among the approved courses. A core course of one department may be chosen as an elective by a student from other department.

3.1.8 Each student is required to make a seminar presentation on any chosen topic connected with the field of specialisation. Preparation and presentation of a seminar is intended to investigate an in-depth review of literature, prepare a critical review and develop confidence to present the material by the student. The seminar shall be evaluated by a Departmental Committee constituted for this purpose, based on a report submitted by the candidate and a viva-voce conducted at the end of the semester.

3.1.9 Project work is envisaged to train a student to analyze independently any problem posed to him/her. The work may be analytical, experimental, design or a combination of both. The project report is expected to exhibit clarity of thought and expression. The evaluation of project work will be a continuous internal assessment based on two reviews, an internal viva-voce and an external viva-voce examination.

3.1.10 The medium of instruction, examination, seminar, directed study and project work will be in English.

4.0 REQUIREMENTS TO APPEAR FOR UNIVERSITY EXAMINATION

4.1 A candidate shall be permitted to appear for university examinations at the end of any semester only if he / she secures not less than 75% overall attendance arrived at by taking into account the total number of periods in all subjects put together offered by the institution for the semester under consideration. Candidates who secure overall attendance greater than 60% and less than 75% have to pay a condonation fee as prescribed by the University along with a medical certificate obtained from a medical officer not below the rank of Assistant Director to become eligible to appear for the examinations.

4.2 A candidate to secure eligibility towards continuing the Programme, he/she must have earned the minimum number of credits at the end of each semester as given in Table – 1. If he /she fails to satisfy this criterion in any semester, he/she shall be placed on scholastic probation in the succeeding semester.

4.3 His / Her conduct shall be satisfactory as certified by the Head of the institution.

5.0 EVALUATION

5.1 Evaluation of theory courses shall be based on 40% continuous internal assessment and 60% University examination. Evaluation of laboratory course shall be based on 50% internal assessment and 50% University examination. In each course, there shall be a 3 hour University examination.

5.2 The total marks for the project work for M.Tech. programmes will be 300 marks for phase-I and 400 marks for phase-II. The allotment of marks for external valuation and internal valuation shall be as detailed below:

Project work – (Phase – I): 300 Marks

Internal valuation			
	Guide		50 marks
	First Evaluation		50 marks
	Second Evaluation		50 marks
		Total	**150 marks**
External valuation			
	Evaluation (External Examiner Only)		50 marks
	Viva voce (50 for Ext.+ 50 for Int.)		100 marks
		Total	**150 marks**

Project work – (Phase – II): 400 Marks

Internal valuation			
	Guide		100 marks
	First Evaluation		50 marks
	Second Evaluation		50 marks
		Total	**200 marks**
External valuation			
	Evaluation (External Examiner Only)		50 marks
	Viva voce (75 for Ext. + 75 for Int.)		150 marks
		Total	**200 marks**

Internal valuation should be done by a committee comprising of not less than 3 faculty members appointed by the Head of the Department and approved by the Head of the Institution.

5.3 The end-semester examination shall be conducted by the Pondicherry University for all the courses offered by the department. A model question paper, as approved by the Chairperson, BOS (MECH), Pondicherry University, for each course offered under the curriculum should be submitted to the University. The University examination shall cover the entire syllabus of the course.

5.4 The University shall adopt the double valuation procedure for evaluating the end-semester examinations, grading and publication of the results. Each answer script shall be evaluated by two experts. If the difference between the total marks awarded by the two examiners is not more than 15% of end-semester examination maximum marks, then the average of the total marks awarded by the two examiners will be reckoned as the mark secured by the candidate; otherwise, a third examiner is to be invited to evaluate the answer scripts and his/her assessment shall be declared final.

5.5 Continuous assessment of students for theory courses shall be based on two tests (15 marks each) and one assignment (10 marks). A laboratory course carries an internal assessment mark of 50 distributed as follows: (i) Regular laboratory exercises and records – 20 marks (ii) Internal laboratory test– 20 marks and (iii) Internal viva-voce – 10 marks.

5.6 All eligible students shall appear for the University examination.

6.0 Grading

6.1 The assessment of a course will be done on absolute marks basis. However, for the purpose of reporting the performance of a candidate, letter grades, each carrying stipulated points, will be awarded as per the range of total marks (out of 100) obtained by the candidate, as detailed below in Table – 2.

TABLE 2: Letter Grade and the Corresponding Grade Point

Range of Total Marks	Letter Grade	Grade Points	Description
90 to 100	S	10	EXCELLENT
80 to 89	A	9	VERY GOOD
70 to 79	B	8	GOOD
60 to 69	C	7	ABOVE AVERAGE
55 to 59	D	6	AVERAGE
50 to 54	E	5	SATISFACTORY
0 to 49	F	0	FAILURE
Incomplete	FA	-	FAILURE DUE TO LACK OF ATTENDANCE/ FAILURE BY ABSENCE

6.2 A student is deemed to have completed a course successfully and earned the appropriate credit if and only if, he /she receives a grade of E and above. The student should obtain 40% of marks in the University examination in a subject to earn a successful grade.

6.3 A candidate who has been declared "Failed" in a course may reappear for that subject during the subsequent semesters and secure a pass. However, there is a provision for revaluation of failed or passed subjects provided he/she fulfills the following norms for revaluation.

(i) Applications for revaluation should be filed within 4 weeks from the date of declaration of results or 15 days from the date of receipt of marks card whichever is earlier.

(ii) The candidate should have attended all the university examinations.

(iii) The candidate should not have failed in more than two papers in the current university examination.

(iv) The request for revaluation must be made in the format prescribed and duly recommended by the Head of the Institution along with the revaluation fee prescribed by the University.

(v) Revaluation is not permitted for practical courses, seminar and project work.

6.4 The internal assessment marks secured by a student in a theory course shall be considered only during the first appearance. For the subsequent attempts, the marks secured by the student in the University examination shall be scaled up to the total marks. Further, the marks secured by the student in the University examination in the latest attempt shall alone remain valid in total suppression of the University examination marks secured by the student in earlier attempts.

6.0 DECLARATION OF RESULTS, RANK AND ISSUE OF GRADE CARD

7.1 The results will be declared and the grade cards will be issued to the students after completing the valuation process.

7.2 The grade cards will contain the following details:

(i) The college in which the candidate is studying/has studied.

(ii) The list of courses enrolled during the semester and the grades scored.

(iii) The Grade Point Average (GPA) for the semester and the Cumulative Grade Point Average (CGPA) of all enrolled subjects from first semester onwards.

7.3 GPA is the ratio of the sum of the products of the number of credits (C) of courses registered and the corresponding grades points (GP) scored in those courses, taken for all the courses and the sum of number of credits of all the courses

$$GPA = (\text{Sum of } (C \times GP) / \text{ Sum of } C)$$

The sum will cover all the courses the student has taken in that semester, including those in which he/she has secured F.

7.4 CGPA will be calculated in a similar manner, considering all the courses enrolled from first semester. FA grades are to be excluded for calculating GPA and CGPA. If a student has passed in a course after failing in earlier attempts, the grade secured by the student in the successful attempt only will be taken into account for computing CGPA.

7.5 To convert CGPA into percentage marks, the following formula shall be used:

$$\% \text{ Mark} = (CGPA - 0.5) \times 10$$

7.6 A candidate who satisfies the course requirements for all semesters and passes all the examinations prescribed for all the four semesters within a maximum period of 10 semesters reckoned from the commencement of the first semester to which the candidate was admitted, shall be declared to have qualified for the award of degree.

7.7 A candidate who qualifies for the award of the degree shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION** upon fulfilling the following requirements:

(i) Should have passed all the subjects pertaining to semesters 1 to 4 in his/her first appearance in 4 consecutive semesters starting from first semester to which the candidate was admitted.

(ii) Should not have been prevented from writing examinations due to lack of attendance.

(iii) Should have secured a CGPA of 8.50 and above for the semesters 1 to 4.

7.8 A candidate who qualifies for the award of the degree by passing all the subjects relating to semesters 1 to 4 within a maximum period of 6 consecutive semesters after his/her commencement of study in the first semester and in addition secures CGPA not less than 6.5 shall be declared to have passed the examination in **FIRST CLASS**.

7.9 All other candidates who qualify for the award of degree shall be declared to have passed the examination in **SECOND CLASS**.

7.10 A student with CGPA less than 5.0 is not eligible for the award of degree.

7.11 For the award of University rank and gold medal, the CGPA secured from 1st to 4th semester should be considered and it is mandatory that the candidate should have passed all the subjects from 1st to 4th semester in the first appearance and he/she should not have been prevented from writing the examination due to lack of attendance and should not have withdrawn from writing the University examinations.

8.0 PROVISION FOR WITHDRAWAL

A candidate may, for valid reasons, and on the recommendation of the Head of the Institution be granted permission by the University to withdraw from writing the entire semester examination as one unit. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire programme. Other conditions being satisfactory, candidates who withdraw are also eligible to be awarded DISTINCTION whereas they are not eligible to be awarded a rank/gold medal.

9.0 TEMPORARY DISCONTINUATION FROM THE PROGRAMME

If a candidate wishes to temporarily discontinue the programme for valid reasons, he/she shall apply through the Head of the Institution in advance and obtain a written order from the University permitting discontinuance. A candidate after temporary discontinuance may rejoin the programme only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees to the University. The total period of completion of the programme reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 5 years, including the period of discontinuance.

10.0 POWER TO MODIFY

10.1 Notwithstanding anything contained in the foregoing, the Pondicherry University shall have the power to issue directions/ orders to remove any difficulty.

10.2 Nothing in the foregoing may be construed as limiting the power of the Pondicherry University to amend, modify or repeal any or all of the above

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M.TECH (COMPUTER AIDED DESIGN)
CURRICULUM AND SCHEME OF EXAMINATION

(Total number of credits required for the completion of the programme: 72)

SEMESTER – I

Sl. No.	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	ME 911	Computational Methods	4	0	0	4	40	60	100
2.	ME 912	Computer Graphics	4	0	0	4	40	60	100
3.	ME 913	Integrated Mechanical Design	4	0	0	4	40	60	100
4.		Elective – I	3	0	0	3	40	60	100
5.		Elective – II	3	0	0	3	40	60	100
6.		Elective – III	3	0	0	3	40	60	100
7.	ME 917	CAD Laboratory	0	0	3	2	50	50	100
						23	290	410	700

SEMESTER – II

Sl. No.	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	ME 914	Finite Element Analysis	4	0	0	4	40	60	100
2.	ME 915	Product Design	4	0	0	4	40	60	100
3.	ME 916	Integrated Product and Processes Development	3	1	0	4	40	60	100
4.		Elective – IV	3	0	0	3	40	60	100
5.		Elective –V	3	0	0	3	40	60	100
6.		Elective – VI	3	0	0	3	40	60	100
7.	ME 918	Analysis and Simulation Laboratory	-	-	3	2	50	50	100
						23	290	410	700

SEMESTER – III

Sl. No.	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.		Elective VII	3	0	0	3	40	60	100
2.	ME 919	Project Phase-I	-	-	16	9	150	150	300
						12	190	210	400

SEMESTER – IV

Sl. No.	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	ME 920	Project Phase II	-	-	24	14	200	200	400
						14	200	200	400

LIST OF ELECTIVES

Sl.No.	Code	Subject
1	ME 941	Advanced Materials and Processing
2	ME 942	Advanced Mechanism Design And Simulation
3	ME 943	Advanced Strength Of Materials
4	ME 944	Advanced Tool Design
5	ME 945	Bearing Design and Rotor Dynamics
6	ME 946	Composite Materials And Mechanics
7	ME 947	Computational Fluid Dynamics
8	ME 948	Design Of Hydraulic And Pneumatic Systems
9	ME 949	Design Of Material Handling Equipment
10	ME 950	Design Of Plastic Parts
11	ME 951	Design Paradigm
12	ME 952	Engineering System Dynamics
13	ME 953	Enterprise Resource Planning
14	ME 954	Flexible Competitive Manufacturing System
15	ME 955	Industrial Design And Ergonomics
16	ME 956	Industrial Robotics And Expert Systems
17	ME 957	Mechanical Vibrations
18	ME 958	Mechatronics In Manufacturing
19	ME 959	Metallic Materials And Manufacturing Processes
20	ME 960	Optimization Techniques In Design
21	ME 961	Plasticity And Metal Forming
22	ME 962	Rapid Prototyping And Tooling
23	ME 963	Total Quality Management
24	ME 964	Tribology In Design

ME 911 COMPUTATIONAL METHODS

Unit - I

Numerical Methods - Solution of Linear Simultaneous equations- direct methods of solution- Gauss elimination method, Gauss Jordon method, Crout's method - iterative methods of solution – Jacobi's method Gauss Seidal method. Determination of Eigen value by iteration – power method.

Unit – II

Ordinary differential equations, Taylor's method, Runge- Kutta method – Milne's predictor – correction method.

Classification of PDE's, one dimensional, Finite Difference Method for Laplace, Poisson's and elliptical equations.

Unit – III

Curve fitting – Method of least squares, fitting straight line, parabola and exponential, polynomial of degree N, applications.

Statistical methods - Statistical Inference- sampling distribution of statistics, standard error, point and internal estimation for population, mean, variance and least square estimate.

Unit - IV

Test of Hypothesis, Inference concerning means, variances and proportions for small and large samples, t, F, chi square tests, goodness of fitness, and test of independence.

Unit - V

Design of experiment – Analysis of variance, one way and two way classification, latin square design, factorial design, test of significance of main and interaction effects.

REFERENCE BOOKS:

1. Miller and Freund, - Probability and statistics for Engineers, Prentice Hall of India, 1995.
2. Douglas C. Montgomery and George C. Runger - Applied Statistic and Probability for Engineers, Wiley Higher Edn,1998
3. Elsgolts, L. Publishers, Moscow, - Differential equation and calculus of variations, Mir 1966.
4. Grewal. B.S. - Higher Engineering Mathematics, Khanna Publishers, 2000

ME 912 COMPUTER GRAPHICS

Unit - I

Principles of Computer Graphics - Point plotting, drawing of lines, Bresenham's circle algorithm. Transformation in Graphics: co-ordinate system used in Graphics and windowing , view port, views, 2D transformations – rotation, scaling, translation, mirror, reflection, shear - homogeneous transformations – concatenation, Viewing and windowing transformations – clipping algorithms- 3D Transformation – Projections – Orthographic – Isometric – Oblique – Technique (Description of techniques only

Unit - II

Geometric Modeling Classification of Geometric Modelling – Wire frame, Surface and Solid Modeling, applications – representation of curves and surfaces – Parametric form – Design of curved shapes- Cubic spline – Bezier curve – B-spline – Hermite curve – Lagrangian – Design of Surfaces - features of Surface Modelling Package - Solid Primitives, CSG, B-rep and description of other modelling techniques like Sweep representation - Analytical solid modeling - Pure primitive instancing, cell decomposition, spatial occupancy enumeration.
An overview of modeling softwares like PRO-E, CATIA, IDEAS, SOLID EDGE etc.

Unit - III

Viewing transformations – perspective projection – techniques for visual realism – hidden line – Surface - solid and curve removal algorithm - Algorithms for shading and Rendering.
Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted parts using these packages.

Unit - IV

Graphics standard & Data storage - Standards for computer graphics GKS, Data exchange standards – IGES, STEP - Manipulation of the model - Model storage - Data structures - Data base considerations - Object oriented representations - Organizing data for CIM applications - Design information system.

Unit - V

2D Representation – Development of surfaces – Integration of design analysis and CAD – Graphical aid for preprocessing in FEA – mesh generation techniques – Post processing – Machining from 3D Model – Generative machining – cutter location – gouge deletion – tool path generation from solid models – STL formats for rapid prototyping – Slicing techniques - Introduction to fractional geometry.

REFERENCES

1. Chris McMohan and Jimmi Browne, "CAD / CAM principles, practice and manufacturing management", Pearson Education Asia, Ltd., 2000.

2. Donald Hearn and M.Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.

3. Ibrahim Zeid "CAD/CAM – Theory and Practice" – McGraw Hill, International Edition, 1998.

4. David.F.Rogers, J.Alan Adams, "Mathematical elements for computer graphics" (second edition), Tata McGraw Hill edition, 1990.

5. William,M.Newman, Robert,F.Sproull, "Principles of interactive computer graphics" (second edition), Tata mcgraw Hill edition, 1997.

ME 913 INTEGRATED MECHANICAL DESIGN

(Use of Approved Data Book Is Permitted)

UNIT I

Phases of design – Standardization and interchangeability of machine elements - Tolerances from process and function – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration.

UNIT II

Analysis and Design of shafts for different applications – detailed design – preparation of production drawings – integrated design of shaft, bearing and casing – design for rigidity.

UNIT III

Principles of gear tooth action – Gear correction – Gear tooth failure modes – Stresses and loads – Component design of spur, helical, bevel and worm gears – Deign for sub assembly – Integrated design of speed reducers and multi-speed gear boxes – application of software packages.

UNIT IV

Introduction-design diagrams of clutch, calculation of critical parameters of clutches, design calculation of standard elements of friction clutches, torsional vibration dampers, clutch control drives.

UNIT V

Dynamics and thermal aspects of vehicle braking – Integrated design of brakes for machine tools – automobiles and mechanical handling equipments

REFERENCES

1. Newcomb, T.P. and Spur, R.T., "Automobile Brakes and Braking Systems", Second Edition, Chapman and Hall, 1975.
2. Juvinall, RL.C., "Fundamentals of Machine Component Design", John Wiley,1983.
3. Maitra G.M., "Hand Book of Gear Design", Tata McGraw Hill, 1985.
4. Shigley, J.E., "Mechanical Engineering Design", McGraw Hill, 1986.
5. Tech. P.S.G., "Design Data Book", Kalaikathir Achchagam, 2003.
6. Lingaiah. K.& Narayana Iyengar, "Machine Design Data Hand Book", Vol.1 & 2, Suma Publishers, 1983
7. Lukin P Gasparyants G and Rodionov V, "Automobile Chassis Design and Calculations", Mir Publishers, 1992.
8. Heinz Heisier, "Vehicle and Engine technology"' SAE, New York, 1999.
9. Gillespie T D, "Fundamentals of Vehicle Dynamics"' SAE Inc., New York, 1992
10.Schwaller A E, "Motor Automotive Technology"' Third Edition, Delman Publishers, New York.

ME 914 FINITE ELEMENT ANALYSIS

UNIT I

Relevance of finite element analysis in design – Modeling and discretization – Interpolation, elements, nodes and degrees-of-freedom – applications of FEA One- Dimensional Elements and Computational Procedures: Bar element – beam element – bar and beam elements of arbitrary orientation – assembly of elements – properties of stiffness matrices-boundary conditions – solution of equations – mechanical loads and stresses – thermal loads and stresses – example problems.

UNIT II

Interpolation and shape functions – element matrices – linear triangular elements (CST) – quadratic triangular elements – bilinear rectangular elements – quadratic rectangular elements – solid elements – higher order elements – nodal loads – stress calculations – example problems.

UNIT III

Introduction – bilinear quadrilateral elements – quadratic quadrilaterals – hexahedral elements – Numerical Integration – quadrature – static condensation – load considerations – stress calculations – examples of 2D and 3D applications.

UNIT IV

Dynamic equations – mass and damping matrices – natural frequencies and modes – damping – reduction of number of degrees-of-freedom – response history – model methods – Ritz vectors – component mode synthesis – harmonic response – direct integration techniques – explicit and implicit methods – analysis by response spectra – example problems.

UNIT V

Heat transfer – element formulation – reduction – nonlinear problems – transient thermal analysis – acoustic frequencies and modes – fluid structure interaction problems – plane incompressible and rotational flows – example problems.

REFERENCES

1. Cook, Robert Davis "Concepts and Applications of Finite Element Analysis ",
Wiley, John & Sons, 1999.

2. Reddy J.N., "An Introduction to the Finite Element Method", McGraw Hill, International Edition, 1993.

3. Chandrupatla & Belagundu, "Finite Elements in Engineering", Prentice Hall of India Private Ltd., 1997.

4. S.S.Rao, "Finite Element Analysis", 2002 Edition.

ME 915 PRODUCT DESIGN

Unit – I

Definition - Design by Evolution and by Innovation - factors to be considered for product design - Production-Consumption cycle - The morphology of design - Primary design Phases and flow charting. Role of Allowance, Process Capability, and Tolerance in Detailed Design and Assembly.
Product strategies, Market research - identifying customer needs - Analysis of product - locating ideas for new products, Selecting the right product, creative thinking, curiosity, imagination and brain storming - product specification– Establishing Target Specifications – Setting the Final Specifications

Unit - II

Task - Structured approaches - clarification - search - external and internal -systematic exploration - concept selection – methodology and benefits.
The value of appearance - principles and laws of appearance - incorporating quality, safety and reliability into design. Man machine considerations - ergonomic considerations - Designing for ease of maintenance.

Unit – III

Modeling and simulation - the role of models in product design, mathematical modeling similitude relations - weighted property index.
Material selection: problems of material selection-performance characteristics of materials - the material selection process-economics of materials-cost versus performance relations-weighted property index.

Unit - IV

Strength Consideration: Principal Stress Trajectories - Balanced Design – Criteria and Objectives of Design – Designing for Uniform Strength – Tension vis –a-vis Compression.
Stiffness and Rigidity consideration: Mapping of Principal Stresses – Buckling and Instability – Plastic Design – Practical Ideas for Material saving in Design – Ribs, Corrugations, Laminates and Membranes.
Design for Production : Forging Design – Pressed Components Design – Casting Design – Design for Machining Ease – Design for PM Parts – Approach to Design with Plastics, Rubber, Ceramics.

Unit - V

Case studies – based on materials and manufacturing of Automobiles Components and Home appliances.
Classes of exclusive rights - Patents - Combination versus aggregation - Novelty and Utility - Design patents - Paten disclosure - Patent application steps-Patent Office prosecution-Sales of paten rights- Trade marks-Copy rights.

REFERENCE BOOKS:

1. Karl.T.Ulrich and Steven D.Eppinger - Product Design and Development, McGraw-Hill International Edn. 2004.
2. Benjamin W.Niebel and Alanb.Draper - Product Design and Process Engineering, McGraw Hill Book Co.,
3. Chitale, A.K. and Gupta, R.C - Product Design and Manufacturing, Prentice Hall, 2002.

ME 916 INTEGRATED PRODUCT AND PROCESSES DEVELOPMENT

UNIT I

Characteristics of Successful Product Development – Who Designs and Develops Products – Duration and Costs of Product Development – Challenges of Product Development – Development Processes and Organizations – A Generic Development Process – Concept Development: The Front-End Process Adapting the Genetic Product Development Process – Product Development Process Flows – The AMF Development Process – Product Development Organizations – The AMF Organization Product Planning Process – Identify Opportunities – Evaluating and Prioritizing Projects – Allocating Resources and Timing – Pre-Project Planning – Reflect on the Results and the Process

UNIT II

Engineering Tolerances – Introduction-need for tolerances-Conventional tolerances-Fits and Limits-Tolerance accumulation-Tolerance-Cost relationship-Surface quality- Datums-Geometric Tolerances-Tolerance practices in drafting and manufacturing-tolerance modeling-tolerance representation-tolerance analysis-tolerance synthesis

UNIT III

Introduction to optimization techniques – fundamentals – classifications, Classical methods – Calculus method – method of Lagrange multipliers , Unconstrained optimization methods – single variable – Exhaustive, Fibonacci, Golden section search methods – Newton Raphson method. Multi variable – Simplex search method – Steepest descent method. Constrained optimization method – cutting plane method. Introduction to genetic algorithm (description of method only).

UNIT IV

Introduction – Single degree freedom free vibration systems – Damped vibrations – Single degree freedom forced vibration with elastically coupled viscous dampers, System Identification from frequency response, Support motion, Duhamel's Integral – Impulse Response function – Virtual work – Lagrange's equation-– Transient Vibration
Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies

UNIT V

Rapid prototyping: Need for rapid prototyping, Basic principles and advantages of RP, General features and classifications of different RP techniques with examples, Introduction to 3 - D RP techniques: Fusion Deposition Modeling, Laminated Object Manufacturing and Stereo-lithography.
Product Architecture – Implications of the Architecture – Establishing the Architecture – Delayed Differentiation – Platform Planning – Related System – Level Design Issues

REFERENCES

1. Karl T.Ulrich and Steven D. Eppinger, "Product Design and Development",
McGraw Hill International Edition, 1999.

2. Kemnneth Crow, "Concurrent Engg. /Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569

3. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4

4. Ibrahim Zeid, "Mastering CAD/CAM", Tata McGraw-Hill Publishing Company Limited. Edition - 2007

5. Stuart Pugh, "Tool Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk, NY, 1991, ISBN 0-202-41639-5

6. Kalyanmoy deb, "Optimization for engineering design" (Algorithms and examples) Prentice Hall of India New Delhi, 2005.

7. Rao, J.S., & Gupta, K. – "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1984.

8. Den Hartog, J.P, "Mechanical Vibrations," Dover Publications, 1990.

9. Rao, S.S.," Mechanical Vibrations," Addison Wesley Longman, 1995.

10. Amitabha Ghosh, "Rapid Prototyping – A Brief Introduction", Affiliated East West Press Pvt. Ltd., 1997

ME 917 CAD LABORATORY

- **CAD** Introduction.
- **Sketcher**
- **Solid modeling** –Extrude, Revolve, Sweep, etc and Variational sweep, Loft ,etc
- **Surface modeling** –Extrude, Sweep, Trim, etc and Mesh of curves, Free form etc
- **Feature manipulation** – Copy, Edit, Pattern, Suppress, History operations etc.
- **Assembly**-Constraints, Exploded Views, Interference check
- **Drafting**-Layouts, Standard & Sectional Views, Detailing & Plotting.

Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc

ME 918 ANALYSIS AND SIMULATION LABORATORY

Analysis of Mechanical Components – Use of FEA packages, like ANSYS NASTRON etc., Excesses shell include FEA analysis of

i) Machine elements under static loads

ii) Heat transfer in mechanical systems

iii) Determination of natural frequency

iv) Axi-Symmetric

v) Non-linear systems

EQUIPMENTS REQUIRED

CAD work station / Pentium 4: 10 Nos

ANSYS / NASTRAN / ABACUS: 10 Licenses

ELECTIVES

ME 941 ADVANCED MATERIALS AND PROCESSING

Unit – I

Introduction: Conventional materials, limitation, need for composites, classification and characteristics of composites, reinforcements,Polymer, ceramics and metal matrix composites – manufacturing of metal matrix composites, solid and liquid state processing-testing of composites- applications

Unit – II

Introduction to powder metallurgy (P/M) Processes – Design considerations for P/M tooling – Types of compaction – Sintering at different atmospheres – Liquid Phase sintering – Secondary processes – P/M applications specifically to cutting tool, bearing and friction materials – Nano materials and their applications.

Unit – III

Newer forming processes specifically with reference to applications – Super plastic forming, rubber forming, explosive, electro – hydraulic and magnetic pulse forming. Special metal joining processes – Ultrasonic welding, Friction welding, Explosive Welding, Electron Beam welding, Diffusion bonding.

Unit – IV

Special material removal processes – Chemical machining, Electro chemical machining, Electrical Discharge machining, wire EDM, Water Jet machining – High speed machining – Micro machining Casting of Non-Ferrous metals.

Unit – V

Surface Structure and properties – Surface coatings, Hard facing, Thermal spraying, Vapor deposition, Ion implantation, Hot dipping – Coating of Cutting and forming tools.

REFERENCE BOOKS:

1. Serope. Kalpakjian and Steven.R.Schmid - Manufacturing Engineering and Technology, Addison Wesley Longman (Singapore) Pvt. Ltd., New Delhi, 2000.
2. Carl Love, L. - Welding Procedures and Applications, Prentice Hall Inc.,1993.
3. H.M.T. - Production Technology, Tata McGraw Hill Publishing Co, 2002.
4 Heine, R.W.. Loper, C.R. and Rosenthal, P.C. - Principles of Metal Casting, Tata McGraw Hill Publishing Co., 1991

ME 942 ADVANCED MECHANISMS DESIGN AND SIMULATION

UNIT I

Review of fundamentals of kinematics – mobility analysis – formation of one D.O.F. multi loop kinematic chains – Network formula – Gross motion concepts.

UNIT II

Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages – Analytical methods for velocity and acceleration Analysis – four bar linkage jerk analysis – Plane complex mechanisms.

UNIT III

Fixed and moving centrodes – Inflection points and Inflection circle – Euler Savary equation – graphical constructions – cubic of stationary curvature.

UNIT IV

Type synthesis – Number synthesis – Associated Linkage Concept – Dimensional synthesis – function generation, path generation, motion generation – Graphical methods – Cognate linkages – Coupler curve synthesis – design of six-bar mechanisms – Algebraic methods – Application of instant center in linkage design – Cam Mechanisms – determination of optimum size of Cams.

UNIT V

Static force analysis with friction – Inertia force analysis – combined static and inertia force analysis – shaking force, Kinetostatic analysis – Introduction to force and moment balancing of linkages. Kinematic Analysis of Spatial RSSR mechanism – Denavit – Hartenberg Parameters –
Forward and inverse Kinematics of Robotic Manipulators Study and use of Mechanism using Simulation Software packages

REFERENCES

1. Sandor G.N. and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.

2. Shigley, J.E., and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw Hill, 1995.

3. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, 1999.

4. Nortron R.L., "Design of Machinery", McGraw Hill, 1999.

5. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.

6 . http://www.machinedesign.com/

ME 943 ADVANCED STRENGTH OF MATERIALS

UNIT I

Stress – Strain relation and General equation of elasticity in cartesian, polar and spherical coordinates- differential equation of equilibrium – compact ability – boundary conditions, representations of three dimensional stress of a tension – generalized Hooke's law – St. Vennant's principle – Plane strain, plane stress – Airy's stress function.
Shear Centre: Location of shear centre for various sections – shear flow.

UNIT II

Stresses and deflection in beams subjected to unsymmetrical loading – Kern of a section. Curved flexural members - circumferential and radial stresses – deflection and radial curved beam with re-strained ends – closed ring subjected to concentrated load and uniform load – chain link and crane hooks.

UNIT III

Thick walled cylinder subjected to internal and external pressures – Shrink fit joints – Stresses due to rotation – Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness – allowable speed. – Rotating shafts and cylinders.

UNIT IV

Torsion of rectangular cross section – St.Vennant Theory – elastic membrane analogy – Prandtl's stress function – Torsional stresses in hollow thin walled tubes.

UNIT V

Stresses in circular and rectangular plates due to various types of loading and end conditions – Buckling of plates. Theory of contact stresses – methods of computing contact stresses – deflection of bodies in point and line contact – applications.

REFERENCES

1. Arthur P.Boresi and Richard J.Schmidt, "Advanced Mechanics of Materials", John, Willey &Sons, Inc., 2003.
2. Arthur P.Boresi and Omar M.Siseborttom, "Advanced Mechanics of Materials", John, Willey International Education, 1985.
3. Robert,D.Cook, Wareen.C.Yound, "Advanced Mechanics of Materials", Macmillon Publishers Company, 1985.
4. Srinath.L.S., Advanced Mechanics of Solids, Tata McGraw Hill Publishing Company Limited, 2003
5. Krishna Raju, N., Gururaja,D.R., Advanced Mechanics of Solids and Structures, Narosa Publishing House, 1997.
6. U.C.Jindal, "Advanced Topics of Strength of materials", Galgotia Publications, First edition, 1997.

ME 944 ADVANCED TOOL DESIGN

UNIT I

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials- Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment

UNIT II

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters

UNIT III

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing- Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations.

UNIT IV

Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies-Design and drafting.

UNIT V

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine

REFERENCES:

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.

2. E.G.Hoffman," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004

3. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000

4. Venkataraman K., "Design of Jigs, Fixtures and Presstools", TMH, 2005

5. Haslehurst M., "Manufacturing Technology", The ELBS, 1978

ME 945 BEARING DESIGN AND ROTOR DYNAMICS

UNIT I

Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic bearings- Electro Magnetic bearings-Dry bearings-Rolling Element bearings- Bearings for Precision Applications-Foil Bearings-Special bearings- Selection of plain Bearing materials – Metallic and Non metallic bearings

UNIT II

Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations- Design based on Charts & Tables and Experimental curves-Design of Foil bearings-Air Bearings- Design of Hydrostatic bearings-Thrust and Journal bearings- Stiffness consideration - flow regulators and pump design

UNIT III

Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication-Fatique life calculations- Bearing operating temperature- Lubrication- Selection of lubricants-Internal clearance – Shaft and housing fit- -Mounting arrangements-Materials for rolling bearings- Manufacturing methods- Ceramic bearings-Rolling bearing cages-bearing seals selection

UNIT IV

Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings – Journal centre Trajectory- Analysis of short bearings under dynamic conditions-Finite difference solution for dynamic conditions

UNIT V

Rotor vibration and Rotor critical speeds- support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients -Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip- Design configurations of stable journal bearings

REFERENCES:

1.Neale, M.J. "Tribology Hand Book", Butterworth Heinemann, United Kingdom 2001.
2. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – "Principles of Tribology ", Macmillian – 1984.
4. Williams J.A. " Engineering Tribology", Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth-Heineman UK, 2005

ME 946 COMPOSITE MATERIALS AND MECHANICS

UNIT I

Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers – Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices – Smart materials - Types and Characteristics.

UNIT II

Characteristics of Fiber-reinforced Lamina – Laminates – Inter-laminar stresses – Static Mechanical Properties – Fatigue and Impact Properties – Environmental effects – Fracture Behavior and Damage Tolerance.

UNIT III

Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes – Quality Inspection methods.

UNIT IV

Stress Analysis of Laminated Composites Beams, Plates, and Shells – Vibration and Stability Analysis – Reliability of Composites – Finite Element Method of Analysis – Analysis of Sandwich structures.

UNIT V

Failure Predictions – Laminate Design Consideration – Bolted and Bonded Joints Design Examples.

REFERENCES

1.Mallick, P.K., Fiber, "Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.

2. Halpin, J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., 1984.

3. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, 1990.

4. Mallick, P.K. and Newman, S., "Composite Materials Technology: Processes and Properties", Hansen Publisher, 1990.

ME 947 COMPUTATIONAL FLUID DYNAMICS

UNIT I

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II

Steady one-dimensional conduction, Two and Three-dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach.

UNIT IV

Steady One-Dimensional and Two-Dimensional Convection – Diffusion, Unsteady onedimensional convection – Diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – Solution of steady heat conduction by FEM – Incompressible flow – Simulation by FEM.

UNIT V

Algebraic Models – One equation model, K – ϵ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

REFERENCES

1 John D. Anderson, Computational Fluid Dynamics, McGraw-Hill International Editions,1995

2 Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer",NarosaPublishing House, New Delhi, 1995.

3 Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.

4 Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.

5 Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer ", Hemisphere Publishing Corporation, New York, USA, 1984.

6 Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1", Fundamental and General Techniques, Springer – Verlag, 1987.

7. Bose, T.X., "Numerical Fluid Dynamics", Narosa Publishing House, 1997

ME 948 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

UNIT I

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics-Determination of volumetric, mechanical and overall efficiencies of positive displacement pumps. Linear and Rotary Actuators – selection, specification and characteristics.

UNIT II

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems. Electrical control solenoid valves, relays, Electro hydraulic servo valves.

UNIT III

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components - safety and emergency mandrels.

UNIT IV

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods - step counter method - compound circuit design - combination circuit design.

UNIT V

Pneumatic equipments- selection of components - design calculations – application –fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

REFERENCES:

1. Bolton. W., "Pneumatic and Hydraulic Systems ", Butterworth –Heinemann, 1997.

2. Antony Espossito, "Fluid Power with Applications", Prentice Hall, 1980.

3. Dudleyt, A. Pease and John J. Pippenger, Industrial Hydraulics, Tata MGraw Hill Prentice Hall, 1985.

4. Andrew Parr, "Hydraulic and Pneumatics" (HB), Jaico Publishing House, 2004.

5. Majumdar, S.R., Oil Hydraulic Systems, Principles and Maintenance, Tata MGraw Hill Prentice Hall, 2001.

ME 949 DESIGN OF MATERIAL HANDLING EQUIPMENT

(Use of approved data book is permitted)

UNIT I

Type, selection and applications of material handling equipments, choice of material handling equipment – hoisting equipment – components and theory of hoisting equipment – chain and ropes – selection of ropes, pulleys, pulley systems, sprockets and drums.

UNIT II

Forged standard hooks – forged Rams horn hooks – solid triangular eye hooks – crane grabs, electric lifting magnetic – grabbing attachments for loose materials. arresting gear – brakes: shoe, band and cone types – elements of shoe brakes – thermal calculation in shoe brakes.

UNIT III

Hand operated trucks – powered trucks – tractors – electronically controlled tractors - hand truck on rails – industrial railroad equipments: locomotives - winches – capstans – turntables – monorail conveyors –pipe rail systems – flat bar monorails. Rail traveling mechanism, cantilever and monorail cranes, cogwheel drive, monocable tramways- reversible tramways.

UNIT IV

Continuous-motion vertical conveyors – reciprocating-motion vertical conveyors – stackers – work levelers and tail gates – industrial lifts – passenger lifts – freight elevators – mast type elevators – vertical skip hoist elevators, bucket elevators: design, loading and bucket arrangements.

UNIT V

Belt conveyors - chain conveyors – apron conveyors – escalators – flight conveyors – roller conveyors - oscillating conveyors - design of belt conveyors, screw conveyors and pneumatic conveyors.

REFERENCES

1. Rudenko. N., Materials Handling Equipment – MIR Publishers, 1969
2. Spivakovsky. A.O and Dyachkov. V.K., Conveying Machines, Volume I and II, MIR Publishers, 1985
3. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981
4. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
5. P.S.G Tech.., Design Data Book, Kalaikathir Achchagam, 2003
6. Lingaiah. K. and Narayana Iyengar, Machine Design Data Hand Book, Vol. 1 & 2, Suma Publishers, 1983
7. Chowdary.R.B and Tagore.G.R.N.– Materials Handling Equipment –Khanna Publishers, 1996

ME 950 DESIGN OF PLASTIC PARTS

UNIT I

Mechanical Properties- Material Selection for Strength – Degradation - Wear Resistance and Frictional Properties- Special Properties - Processing - Costs. Mechanical Behavior of Plastics-Short term tests -Long term testing -Design Methods for Plastics using deformation data - Pseudo-Elastic design method for plastics-Thermal stresses and Strains- - Time Temperature Superposition - Fracture behavior - Creep behavior - Impact behavior.

UNIT II

Manufacturing Considerations -Mold Filling Considerations -Weld line-Shrinkage and Warpage - Cooling and Solidification-Structural design Considerations-Structural Members-Design for Stiffness - Processing Limitations in Product Design.

UNIT III

Types of moulds and dies for various processing methods - Mould and Die Design Concept and Materials. Injection Mould Design - Basics of mould construction - Methodical Mould Design - Design of Feed System, Ejection System - Venting - Design of Cooling system - Mould alignment concepts and Demoulding Techniques.

UNIT IV

Basics of mould construction - Mould design -Positive moulds- Positive moulds with Lands-Multi cavity moulds with individual, common Loading Chamber - Moulds with a slide core - Split cavity moulds, Heat losses and energy requirement.

UNIT V

Materials Selection, Mould Cooling, Clamping Force, Venting, Pinch-off, Head die design, Parison Diameter Calculation, Wall Thickness, Vertical-load strength, Blow ratio, Base pushup, Neck and Shoulder Design, Thread and beads, Bottom Design. Extrusion Die Design - Die geometry, Die Design, Materials and Classification.

REFERENCES

1 P.S.Cracknell and R.W Dyson, Handbook of Thermoplastics - Injection Mould Design, Chapman & Hall, 1993.
2 Laszlo Sors and Imre Balazs, Design of Plastics Moulds and Dies, Elsevier, Amsterdam, 1989.
3 R.G.W.Pye, Injection Mould Design, SPE Publication, 2000.
4 R J Crawford, Plastics Engineering, Butterworth-Heinemann, Oxford, 1999
5 Edward Miller(Ed), Plastics Product Design Handbook Part A –Materials and Components, Marcel Dekker, 1981.
8 R.A Malloy, Plastic Part Design for Injection Molding An Introduction, Hanser, 1997
7 N. Rao, K O'Brien, Design Data for Plastics Engineers, Hanser, New York, 1998

ME 951 DESIGN PARADIGM

UNIT I

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits – Datum features - Tolerance stacks.

UNIT II

Redesign of castings based on parting line considerations - Minimizing core requirements - Redesigning a cast members using weldments-factors influencing form design-Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials-on from design - form design of welded members, forgings and castings.

UNIT III

Assembly processes-Handling and insertion process-Manual, automatic and robotic assembly-Cost of Assembly-Number of Parts-DFA guidelines

UNIT IV

Value –types –functional –operational –aesthetic –cost- –material – Design process – value and worthiness –procedure -brainstorming sessions –evaluation –case studies –value estimation- Value analysis - Design for value - Selection of alternatives - optimization – Implementation

UNIT V

Elements of Economics analysis-Quantitative and qualitative analysis-Economic Analysis process-Estimating magnitude and time of future cash inflows and out flows-Sensitivity analysis-Project trade-offs-Trade-offs rules-Limitation of quantitative analysis-Influence of qualitative factors on project success

REFERENCES:

1. Harry Peck, Designing for Manufacture, Pitman Publications, 1983.
2. George E Dieter, Engineering Design,McGraw-Hill Int Editions, 2000
3. S.S.Iyer, Value Engineering, New Age International, 2000
4. Charles E. Ebeling, Reliability and Maintainability Engineering, TMH, 2000

ME 952 ENGNEERING SYSTEM DYNAMICS

UNIT I

Introduction – Dynamic system classification – Analysis and Design of Dynamic system – Mathematical modeling of Dynamic systems – Mechanical systems – Electrical systems – Electromechanical Systems – Fluid & Thermal system – Review of vibration of single degree – Two degree freedom systems – Review of matrix algebra and Laplace Transforms.

UNIT II

Introduction – Control systems – Control system configurations – Control system Terminology – Control system classes – Feedback systems – Analysis of Feedback – Historical Developments of control systems – Control system analysis and Design Objectives.

UNIT III

Introduction – Block Diagrams – Block Diagrams Representation – Block Diagram Reduction – Signal flow graphs – Signal flow graph algebra – Mason's Gain formula – Zeros and Additional poles.

UNIT IV

Introduction – Properties of feedback – Transient response specifications – Controller types and actions – Stability of control systems – Routh-Hurwitz criterion – Steady state error – Control system types.

UNIT V

Introduction – analysis of control systems – Root-Locus analysis – Bode analysis – Nyquist analysis – Nyquist stability criterion – Nichols chart analysis – Frequency Domain specifications.

REFERENCES

1. Rao.V.Dukkipati, "Engineering system Dynamics", Narosa Publishing House, 2004.

2. Benjamin C.Kuo, "Automatic Control systems", Prentice-Hall of India Pvt. Ltd., 1995.

3. Thomson W.T., "Theory of Vibration with Applications", CBS Publishers and Distributors, 1990.

ME 953 ENTERPRISE RESOURCE PLANNING

UNIT I

Principle – ERP framework – Business Blue Print – Business Engineering vs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

UNIT II

Client / Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework

UNIT III

SAP – People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.

UNIT IV

Overview – Architecture – AIM – applications – Oracle SCM – SAP: Overview – Architecture – applications – Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package – Oracle ERP and MAXIMO, including ERP on the NET

UNIT V

Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.

REFERENCES

1. Sadagopan. S , "ERP – A Managerial Perspective", Tata McGraw Hill, 1999.

2. Jose Antonio Fernandez, "The SAP R/3 Handbook", Tata McGraw Hill, 1998.

3. Vinod Kumar Crag and N.K.Venkitakrishnan, "Enterprise Resource Planning – Concepts and Practice", Prentice Hall of India, 1998.

4. Garg & Venkitakrishnan, "ERPWARE, ERP Implementation Framework", Prentice Hall, 1999.

5. Thomas E Vollmann and Bery Whybark, "Manufacturing and Control Systems', Galgothia Publications, 1998.

ME 954 FLEXIBLE COMPETITIVE MANUFACTURING SYSTEM

UNIT I

Automation of manufacturing process - Numerical control – Adaptive control – material handling and movement – Industrial robots – Sensor technology – flexible, fixturing – Design for assembly, disassembly and service.

UNIT II

Part families – classification and coding – Production flow analysis – Machine cell design – Benefits.

UNIT III

Introduction – Components of FMS – Application workstations – Computer control and functions – Planning, scheduling and control of FMS – Scheduling – Knowledge based scheduling – Hierarchy of computer control – Supervisory computer.

UNIT IV

System issues – Types of software – specification and selection – Trends – Application of simulation – software – Manufacturing data systems – data flow – CAD/CAM considerations – Planning FMS database.

UNIT V

Characteristics of JIT – Pull method – quality – small lot sizes – work station loads – close supplier ties – flexible work force – line flow strategy – preventive maintenance – Kanban system – strategic implications – implementation issues – MRD JIT – Lean manufacture.

REFERENCES

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice-Hall of India Pvt. Ltd., 1996.

2. Jha, N.K. "Handbook of Flexible Manufacturing Systems", Academic Press Inc., 1991.

3. Kalpakjian, "Manufacturing Engineering and Technology", Addison-Wesley Publishing Co., 1995.

4. Taiichi Ohno, Toyota, "Production System Beyond Large-Scale production", Productivity Press Pvt. Ltd., 1992.

5. http://www.engineeringtalk.com/news/lvd103.htm

ME 955 INDUSTRIAL DESIGN AND ERGONOMICS

UNIT I

Introduction - general approach to the man - machine relationship - work station design - working position - An approach to industrial design - elements of design - structure for industrial design in engineering application in modern manufacturing systems.

UNIT II

Ergonomics and product design - ergonomics in automated systems - expert systems for ergonomic design. Anthropomorphic data and its applications in ergonomic design - limitations of anthropomorphic data - use of computerized data base.
Shapes and sizes of various controls and displays – multiple display and control situations - design of major controls in automobiles, machine tools etc., and - design of office furniture - redesign of instruments.

UNIT III

The mechanics of seeing - psychology of seeing - general influences of line and form.
Colour and light - colour and objects - colour and the eye - colour consistency - colour terms - reactions to colour and colour continuation - colour on engineering equipments.

UNIT IV

Concept of unity - concept of order with variety - concept of purpose - style and environment - Aesthetic expressions. Style - components of style - house style, observing style in capital goods.

UNIT V

General design situation - specifying design requirements - rating the importance of industrial design - industrial design in the design process.

REFERENCES:

1. Mayall W. H., "Industrial design for Engineers", London Iliffee Books Ltd, 1988.

2. Brian Shackel (Edited), "Applied Ergonomics Hand Book", Butterworth Scientific, London, 1989.

3. Dale Huchinson R., "New Horizons for Human Factors in Design", Mc Graw Hill book company, 1990.

4. Robert W. Bailey, "Human Performance Engineering", Prentice Hall Inc., New Jercey, 1991.

ME 956 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS

UNIT I

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – Classifications of Robots. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III

Transducers and Sensors – Sensors in Robot – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Gribbing – Image processing and analysis – Image segmentation – Pattern recognition – Training of vision system.

UNIT IV

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.

UNIT V

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of Artificial Intelligence in Robots.

REFERENCES:

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
2. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987.
3. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.
4. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
5. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
6. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
7. Timothy Jordanides et al ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.

ME 957 MECHANICAL VIBRATIONS

UNIT I

Introduction – Single degree freedom free vibration systems – Damped vibrations – Single degree freedom forced vibration with elastically coupled viscous dampers, System Identification from frequency response, Support motion, Duhamel's Integral – Impulse Response function – Virtual work – Lagrange's equation-– Transient Vibration

UNIT II

Free vibration of spring-coupled system – mass coupled system – Vibration of two degree freedom system – Forced vibration – Vibration Absorber – Vibration isolation.

UNIT III

Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and eigen vectors – orthogonal properties – Modal matrix-Modal Analysis – Forced Vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies.

UNIT IV

Systems governed by wave equations – Vibration of strings – vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation – Vibration of plates.

UNIT V

Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies.

REFERENCES:

1. Benson H.Tongue, Principles of Vibration, 2nd edn., Oxford University Press, NY, 2002

2. Thomson, W.T. – "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.

3. Rao, J.S., & Gupta, K. – "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1984.

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5. Rao, S.S.," Mechanical Vibrations," Addison Wesley Longman, 1995.

ME 958 MECHATRONICS IN MANUFACTURING

UNIT I

Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems - Control Systems.

UNIT II

Introduction - Performance Terminology – Potentiometers - LVDT - Capacitance sensors - Strain gauges - Eddy current sensor - Hall effect sensor - Temperature sensors - Light sensors - Selection of sensors - Signal processing.

UNIT III

Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric – Magnetostrictive - Shape memory alloy - applications - selection of actuators.

UNIT IV

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

UNIT V

Designing - Possible design solutions-Traditional and Mechatronics design concepts - Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine - Engine Management system - Automatic car park barrier - Data acquisition Case studies.

REFERENCES

1. Bolton.W, "Mechatronics" , Pearson education, second edition, fifth Indian Reprint, 2003
2. Smaili.A and Mrad.F , "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008
3. Devadas Shetty and Richard A.Kolk, "Mechatronics systems design", PWS Publishing company, 2007.
4. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
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6. Michael B.Histand and Davis G.Alciatore," Introduction to Mechatronics and Measurement systems". McGraw Hill International edition, 1999.
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8. Lawrence J.Kamm, "Understanding Electro-Mechanical Engineering – An Introduction to Mechatronics", Prentice Hall of India Pvt Ltd, 2000.
9. Dan Necsulescu, "Mechatronics", Pearson education, 2002.
10. Newton C.Braga, "Mechatronics Sourcebook", Thomson Delmar Learning, Eswar Press, 2003.

ME 959 METALLIC MATERIALS AND MANUFACTURING PROCESSES

UNIT I

Factors for design based on mechanical, electrical and thermal properties – Dimensional geometrical tolerances – Factors considered for selection of materials.

UNIT II

Ferrous metals and alloys – Steel, Stainless steel – Non-ferrous metals and alloys – Aluminium – Brass – Gun Metal

UNIT III

Design consideration in methods of manufacturing such as Casting – Sand casting , die casting, investment casting – Machining: Turning, drilling, milling and grinding – Unconventional – EDM, ECM – Forming techniques – Forging, extrusion, sheet metal forming – Powder metallurgy.

UNIT IV

Press fitting – riveting – screw fastening – flanged connections of tubular parts – Joining of parts by welding, brazing and soldering.

UNIT V

Case studies on optimization of design for cost – material – methods – Economics of machining.

REFERENCES

1. Crane, F.A.A. and Charles, J.A., "Selection and use of Engineering Materials", Third Edition, Butterworth's and Co., 1997.

2. Gladius Lewis., "Selection of Engineering Materials", PHI, 2002.

3. Scrope Kalpakgain and Steven Schmid., "Manufacturing processes for Engineering materials", Fourth Edition, Pearson Education Pvt. Ltd., 2003.

4. Dieter G.E., "Mechanical metallurgy", McGraw Hill, 2002.

5. James Brown, "Advanced Machining Technology Hand book", McGraw-Hill, 1998

6. Kenneth G.Budingski, "Surface Engineering for wear Resistance", Prentice Hall, 1988.

ME 960 OPTIMIZATION TECHNIQUES IN DESIGN

UNIT I

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints – Classification of optimization problem.

UNIT II

Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, pattern and gradient search methods – Interpolation methods.

UNIT III

Optimization with equality and inequality constraints - Indirect methods using penalty functions, Lagrange multipliers; Geometric programming- Constrained, mixed inequality and unconstrained minimization; Genetic algorithms.

UNIT IV

Structural applications – Design of simple truss members. Design applications – Design of simple axial, transverse loaded members for minimum cost, maximum weight – Design of shafts and torsionally loaded members – Design of springs.

UNIT V

Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

REFERENCES

1. Singiresu S.Rao., "Engineering Optimization Theory and Practice", New Age International (P) Limited, Publishers 1996.

2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.

3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995.

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5. Saravanan.R, "Manufacturing optimization through intelligent techniques", Taylor and Francis Publications, CRC Press, 2006.

ME 961 PLASTICITY AND METAL FORMING

UNIT I

Theory of plastic deformation – Engineering stress and strain relationship – Stress tensor – Strain tensor – Yield criteria's – Plastic stress strain relationship – Plastic work – Equilibrium conditions – Incremental plastic strain

UNIT II

Uniaxial tension test – Mechanical properties – Work hardening – Compression test – bulge test – plane strain compression stress – plastic instability in uniaxial tension stress – plastic instability in biaxial tension stress

UNIT III

Slab analysis – Slip line method – upper bound solutions – statistically admissible stress field – numerical methods – contact problems – effect of friction – thermo elastic Elasto plasticity – elasto visco plasticity – Thermo mechanical coupling – Analysis of forging – rolling – extrusion and wire drawing processes – Experimental techniques of the evaluation of metal forming

UNIT IV

Bending theory – Cold rolling theory – Hill's anisotropic theory – Hill's general yield theory – Sheet metal forming – Elements used – Mesh generation and formulation – Equilibrium equations – Consistent full set algorithm – Numerical solutions procedures – examples of simulation of simple parts – Bench mark tests – Forming limit diagrams

UNIT V

Orbital forging – Isothermal forging – Warm forging – Hot and Cold isotropic pressing – high speed extrusion – rubber pad forming – micro blanking – Overview of Powder Metal techniques – Powder rolling – Tooling and process parameters

REFERENCES

1. Wagoner. R H., and Chenot. J.J., "Metal Forming Analysis", Cambridge University Press, 2002.

2. Slater. R.A.C., "Engineering Plasticity - Theory & Applications to Metal Forming", John Wiely and Sons, 1987.

3. Shiro Kobayashi, Altan. T, "Metal Forming and Finite Element Method", Oxford University Press, 1989.

4. Narayanaswamy. R, "Theory of Metal Forming Plasticity", Narosa Publishers, 1999.

5. Hosford. W. F and Caddell. RM., "Metal Forming Mechanics and Metallurgy", Prentice Hall Eaglewood Cliffs, 1993.

ME 962 RAPID PROTOTYPING AND TOOLING

UNIT I

Introduction: Need for time compression in product development, Product development – conceptual design – development – detail design – prototype – tooling.

UNIT II

Classification of RP systems, Stereo lithography systems – Principle – process parameters – process details – machine details, Applications. Direct Metal Laser Sintering (DMLS) system – Principle – process parameters – process details – machine details, Applications

UNIT III

Fusion Deposition Modeling – Principle – process parameters – process details – machine details, Applications. Laminated Object Manufacturing – Principle – process parameters – process details – machine details, Applications

UNIT IV

Solid Ground Curing – Principle – process parameters – process details – machine details – Applications – 3-Dimensional printers – Principle – process parameters – process details – machine details – Applications – other concept modelers like thermo jet printers – Sander's model maker – JP system 5 – Object Quadra system.

UNIT V

Laser Engineering Net Shaping (LENS) – Ballistic Particle Manufacturing (BPM) – Principle – Introduction to rapid tooling – direct and indirect method – software for RP – STL files, Magics, Mimics – Application of Rapid prototyping in Medical field.

REFERENCES

1. Pham,D.T. & Dimov.S.S., "Rapid manufacturing", Springer-Verlag, 2001.

2. Terry wohlers, "Wohlers Report 2000", Wohlers Associates, 2000.

3. Paul F Jacobs, "Rapid Prototyping and manufacturing – Fundamentals of Streolithography", Society of Manufacturing Engineering Dearborn, 1992.

4. Rapid Prototyping and Tooling, Industrial Design Centre, IIT, 1998

ME 963 TOTAL QUALITY MANAGEMENT

UNIT I

Need for TQM, evolution of quality, Definition of quality, TQM philosophy – CONTRIBUTIONS OF Deming Juran, Crosby and Ishikawa, TQM models.

UNIT II

Vision, Mission, Quality policy and objective Planning and Organization for quality, Quality policy Deployment, Quality function deployment, introduction to BPR and analysis of Quality Costs.

UNIT III

Customer focus, Leadership and Top management commitment, Employee involvement – Empowerment and Team work, Supplier Quality Management, Continuous process improvement, Training, performance Measurement and customer satisfaction.

UNIT IV

PDSA, The Seven Tools of Quality, New Seven management tools, Concept of six sigma, FMEA, Bench Marking, JIT, POKA YOKE, 5S, KAIZEN, Quality circles.

UNIT V

Need for ISO 9000 Systems, clauses Documentation, Implementation, Introduction to ISO14000 and OSHAS18000, Implementation of TQM, Case Studies.

REFERENCES:

1. Dale H.Besterfiled, "Total Quality Management", Pearson Education Asia, (Indian reprint 2002)
2. Oakland.J.S. "Total Quality Management", Butterworth–Hcinemann Ltd., Oxford, 1989.
3. Narayana V. and Sreenivasan, N.S., "Quality Management – Concepts and Tasks", New Age International 1996.
4. Zeiri. "Total Quality Management for Engineers", Wood Head Publishers, 1991.
5. Juran J.M and Frank M.Gryna Jr., "Quality Planning and Analysis", TMH, India, 1982.
6. Brain Rethery, ISO 9000, Productivity and Quality Publishing Pvt.Ltd., 1993.
7. D.Mills, Quality Auditing, Chapman and Hall, 1993.

ME 964 TRIBOLOGY IN DESIGN

UNIT I

Topography of surfaces – Surfaces features – Experimental Determinations of surface structure – Chemical analysis of surface – surface effects in Tribology – Analysis of surface roughness – measurement of surface roughness. Friction – Mechanism of friction, measuring friction, equations and models of friction – Friction properties of metallic and non metallic materials, friction in extreme conditions. Wear – Types, mechanism, mapping, measurements, wear resistance materials – surface treatment, surface modifications and surface coatings. Computer Simulations of friction, lubrication and wear.

UNIT II

Lubricants – selection criteria – lubrication regimes – Hydrodynamic, elasto and plasto hydrodynamic lubrication, basic equations, Reynold's equation, energy equation, boundary lubrication, boundary lubricating films and its properties. Hydrostatic lubrication – Gas lubrication

UNIT III

Dynamic analysis of hydrodynamic bearing performance, trust and journal bearings– full, partial,
fixed and pivoted – mass flow rate, friction, power loss, heat and temperature difference, dynamic loads, oil film thickness, stiffness of squeeze film and dynamic co-efficient – hydrostatic bearing design.

UNIT IV

Slider bearings – self acting finite bearings, failure modes, materials rolling element bearings – Types, contact mechanics, bearing internal load distribution, lubrication – Bearing geometry and kinematics, load ratings and life prediction, torque calculation, temperature analysis, endurance testing and failure analysis.

UNIT V

Introduction – Mechanism, components, liquid and solid lubricants, accelerated testing and life testing of space mechanism. Principles of Aerospace eccentric bearing test mechanism. Engine Tribology –importance, lubrication regimes, engine bearings, wheel bearings, tire. Mechanics of load transfer – contact area and normal pressure distribution, brakes, effects of service on engine oil properties. Tribology in manufacturing – macro and micro tribology of MEMS materials. Technologies for machinery diagnosis and prognosis.

REFERENCES

1. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981.
2. Hulling, J. (Editor) – " Principles of Tribology", MacMillan, 1984.
3. Williams, J.A. "Engineering Tribology", Oxford University Press, 1994.
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