POST GRADUATE PROGRAMS
CURRICULA AND SYLLABI

(Including Policies and Procedures)

M TECH AND M C A

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AMRITA
VISHWA VIDYAPEETHAM
UNIVERSITY
Established under Section 3 of the UGC Act 1956

श्रद्धावान् लभते ज्ञानम्

Amritanagar, Coimbatore - 641 112.

AMRITAPURI, BANGALORE, COIMBATORE,
KOCHI, MYSORE

2012 and 2013 Admissions

I. POLICIES AND PROCEDURES

With the aim of developing a strong postgraduate and research culture, Amrita Vishwa Vidyapeetham offers postgraduate programs in Engineering, Medicine, Sciences, Business Management etc. This booklet contains the curricula and syllabi for all the Post Graduate Programs in Engineering together with the relevant Policies and Procedures

1. Policies

M. Tech

1. The duration of the M.Tech. Program shall normally be four semesters (2 years).
2. The M.Tech. Program will be known as: M.Tech. in <Name of specialization>. For example, if the M.Tech is offered with specialization in Embedded Systems, it will be called M.Tech in Embedded Systems. There will be no mention of the name of the Department(s) offering the programme. The University encourages inter-departmental PG Programmes.
3. The requirement shall be 50 to 52 credits of prescribed course work and 14 credits of project work totaling 64 to 66 credits for the award of the M.Tech.Degree of the University.
4. The medium of instruction shall be English.

M.C.A

1. The duration of the MCA program shall normally be six semesters (3 years).
2. The requirement shall be 116 credits of prescribed course work including 17 credits of project work.
3. The medium of instruction shall be English.

2. Structure of M.Tech/ MCA Programs

2.1 General Structure

M.Tech./ MCA programs are structured under credit based continuous assessment following semester pattern. Each program will have curricula and syllabi which will be updated necessarily once in two years based on the recommendations of the Board of Studies for the programs concerned. The Board of Studies will consist of experts from other leading academic institutions and R & D establishments in addition to the senior faculty from the University. However the faculty can offer electives of current interest, in between also, with the approval of CPGP.

2.2 Credit Requirements

The credits are generally assigned to the courses based on the pattern given under:

- One credit for each lecture period per week
- One credit for each tutorial period per week
- One credit for each laboratory/ practical course of three periods per week.

MTech:

This is generally a course work intensive program comprising of three semesters of course work ending with a dissertation in the fourth semester. The requirement shall be 50 to 52 credits of course work, and 14 credits of project / dissertation work totaling to 64 to 66 credits for the award of the M.Tech. Degree of the University. All the courses shall be University approved post-graduate courses, and the credits shall be earned as per the following category guidelines (specialization -wise details are given in the PG Programs - Curricula and Syllabi book)

- Core Courses: 35 to 40 credits
- Project / Dissertation Work: 14 credits (Minor Project – 4 credits + Dissertation – 10 credits)
- Remaining credits from Electives

MCA:

For MCA, the requirement is 116 credits including two credits of Minor Project and fifteen credits of Major Project Work.

2.3 Faculty Advisor

Upon admission, every M.Tech./ MCA student will be assigned a faculty advisor by the Chairman of the Department concerned. The faculty advisors will advise the students in all academic activities including registration, selection of electives, choosing projects etc. They will also counsel them wherever/ whenever required and advise them in non-academic matters also when needed.

2.4 Course Committee

For a given course, all the campuses will be governed by the same curricula and syllabi. When the same courses are offered in more than one campus, there will be a course committee for each

course offered. The committee will consist of mentors, one from each campus nominated by the Chairperson of the Department in that Campus and a convener will be chosen from among them. In addition, there will be two student representatives in this Committee, who will be invited for all meetings except those dealing with question papers and other confidential matters. The course committee shall meet in the beginning of the semester to finalise the teaching program as well as evaluation pattern and, at the mid of the semester to finalise the question papers and the keys for the end semester examination of the particular course. The question for the end semester examination will be common for all the campuses. The mentor in each campus will coordinate all the aspects pertaining to the course in that campus.

2.5 Registration

It is necessary that every student registers for each and every course (including project / dissertation work) within the stipulated time by filling up the required form and getting it approved by the faculty concerned. Any violation may lead to non-acceptance of the course registration.

A student is permitted to register/ enroll for courses if and only if he/she has:

- Paid all fees and has no dues to the University
- Has maintained the progress as required by the University
- Has completed pre-requisite courses, if prescribed
- Has no disciplinary action pending against him/ her

Every student will be given a copy of the booklet listing all the M.Tech and MCA courses (containing the relevant Policies, Procedures, syllabus, credits etc) offered. The students doing their Master's programme in one specialization can take courses offered in another specialization / Department, with prior approval of the mentor and Chairman concerned.

Except for the first semester, registration for a given semester shall be done during a week specified before the end semester examination of the previous semester. The consent of the faculty advisor and the course instructor are necessary for registration.

2.6 Evaluation

In theory courses (taught primarily in the lecture mode), the continuous assessment (sessionals) will be for 50% and end semester(final) examination for 50%, making it to 100%. For the continuous assessment, there will be two tests (dates will be given by the Controller of Examination) and a minimum of two assignments. The faculty can give more assignments, seminars, tutorials etc. In the case of laboratory courses and practicals, the weights for continuous assessment and end semester examination shall be 70:30. The weights for the components of continuous assessment will be decided by the course committee in the beginning of the course itself. It is mandatory that the students appear for the end semester examination for the completion of the course. The pass minimum shall be 40% marks in all the subjects. In addition, the students should get a separate minimum of 30% marks each in the end semester examination as well as from the sessionals. It is necessary the students are informed of these in the beginning itself.

2.7 Failures

The failed students can appear for the supplementary examination(s).In addition, those students who could not appear for the end semester examination due to illness, or reasons beyond their control will be also permitted to appear for the supplementary examination(s). The students who have passed the examination are not permitted to appear for the supplementary examination for improving their grades. The grade FA once awarded stays in record and it is not deleted even after he/she completes the course successfully later.If the student fails in the supplementary examination also, he/ she has to re-register for the course and satisfy all the requirements expected of fresh registrants. Such of those who fail due to lack of attendance (FA grade) will not be allowed to appear for the supplementary examination and they have to re-register for the course. In the case of core courses, it is mandatory to successfully complete the same core course. However, in the case of electives, if the student fails in the supplementary examination and the particular course is not offered during the program period (of two years), the CPGP may approve an equivalent course, on the recommendation of the advisor and the Dept Chairman.

In the exceptional case of the students not in a position to complete the requirements within two years, they have to extend their stay by one or two semesters as the case may be, pay the fees like any other student, once again register for the course(s) and successfully complete as per the normal requirements.

2.8 Dissertation/ Project Work

For MTech: Minor Project/ Dissertation

Every M.Tech. student is required to register for 4 credits of Minor Project along with other courses during the third semester and, 10 credits of Dissertation during the fourth semester after completing all the course requirements, under a faculty member, within or outside the Department, and that particular faculty member will be referred to as the student's M.Tech. Advisor. The Dissertation can be a logical continuation of the Minor Project.

In order to earn the credits for the Dissertation, the students are strongly encouraged to work full-time as an intern in a project hosted at outside industry or Institution of calibre, in which case, the student is required to have an external M.Tech. Co-Advisor. It is necessary that a small write up about the dissertation and a statement that it is of M.Tech. level dissertation at the University is submitted by the M.Tech. Advisor to the CPGP through the Chairman for approval. The other administrative requirements are also to be satisfied to get the approval of the Dean/ Principal for carrying out the dissertation outside the University.

Towards the end of completing the dissertation work, the M. Tech. student is required to submit a Dissertation Report, documenting all the results, including system design, implementation, theory, experiments, and performance evaluation, as applicable. The dissertation report is submitted to the M.Tech.Advisor. Wherever applicable, an evaluation (qualitative or quantitative) by the M.Tech. Co-Advisor will be also taken into account by the M.Tech. Advisor.

The CPGP, may invite external experts to help the final evaluation of the students' dissertations. The CPGP will assign each M.Tech. Student's report to a Committee (which is usually headed by the Chairman of that Department and consists of the M.Tech. Advisor(s) and senior faculty of the Department). In case the M.Tech. Advisor and the Chairman are same, the Vice Chairman of the Department will head the Committee. There are two parts to the evaluation. In the first part, which is open to public, all M.Tech. students are required to briefly present their work. In the second part, which is closed-door (with just the Committee members in attendance), a thorough discussion about the dissertation may be carried out, at the conclusion of which, for each Student, the Committee will assign a numerical score out of a maximum of hundred. After completing the evaluation of all the M.Tech. students in that specialization, all the M.Tech. Advisors in that specialization and the Chairman meet and assign every student a letter grade. If the dissertation is not satisfactory, the student will be asked to continue the dissertation and appear for the assessment later and an "I" grade will be given.

For MCA: Minor Project/ Major Project

Every MCA student is required to register for 2 credits of Minor Project along with other courses during the fifth semester and, after completing all the course requirements, 15 credits of Major Project during the sixth semester, under a faculty member, within or outside the Department, and that particular faculty member will be referred to as the student's MCA Advisor.

In order to earn the credits for the Major Project, the students are strongly encouraged to work full-time as an intern in a project hosted at outside industry or Institution of calibre, in which case, the student is required to have an external MCA Co-Advisor. It is necessary that a small write up about the Major Project and a statement that it is of MCA level Project at the University is submitted by the MCA Advisor to the CPGP through the Chairman for approval. The other administrative requirements are also to be satisfied to get the approval of the Dean/ Principal for carrying out the dissertation outside Amrita.

Towards the end of completing the Major Project, the MCA student is required to submit a Project Report, documenting all the results, including system design, implementation, theory, experiments, and performance evaluation, as applicable. The Project Report is submitted to the MCA Advisor. Wherever applicable, an evaluation (qualitative or quantitative) by the MCA Co-Advisor will be also taken into account by the MCA Advisor.

The CPGP, may invite external experts to help the final evaluation of the students' Project Works. The CPGP will assign each MCA Student's report to a Committee (which is usually headed by the Chairman of that Department and consists of the MCA Advisor(s) and senior faculty of the Department). In case the MCA Advisor and the Chairman are same, the Vice Chairman of the Department will head the Committee. There are two parts to the evaluation. In the first part, which is open to public, all MCA students are required to briefly present their work. In the second part, which is closed-door (with just the Committee members in attendance), a thorough discussion about the Project Work may be carried out, at the conclusion of which, for each Student, the Committee will assign a numerical score out of a maximum of hundred. After completing the evaluation of all the MCA students in that specialization, all the MCA Advisors in that specialization and the Chairman meet and assign every student a letter grade. If the Project Work is not satisfactory, the student will be asked to continue the dissertation and appear for the assessment later and an "I" grade will be given.

3. Grading

3.1 Award of Grades

Based on the performance in each course, a student is awarded at the end of the semester a letter grade in each of the courses registered, in a ten point scale. The letter grades, the corresponding grade points and the ratings are as follows:

Letter Grade	Points	Ratings
A+	10	Outstanding
A	10	Excellant
B+	9	Very Good
B	8	Good
C+	7	Above Average
C	6	Average
D	5	Pass
F	0	Failure
FA	0	Failed due to lack of attendance
I	0	Incomplete
W	-	Withheld

Note:

1."FA" grade once awarded stays in the record of the student and is not deleted even after he/she completes the course successfully later.

2. The "I" grade will be subsequently changed into an appropriate grade when the student passes the supplementary examination.

1.A+ shall be given only for exceptionally good performance

2.The student has to successfully complete all the course requirements before carrying out the Dissertation/ Major Project. In case of failures, they shall credit the courses as and when offered.

3.In case of students obtaining F grade, they will be allowed to appear for the supplementary examination for those subjects.

4.If necessary, the student will be allowed to continue beyond four / six semesters, as per the University norms, to successfully complete the courses.

3.2 Semester Grade Point Average (SGPA)

On completion of a semester, each student is assigned Semester Grade Point Average (SGPA) which is computed as below for all courses registered by the student during that semester.

$$\text{Semester Grade Point Average} = \frac{\Sigma(C_i \times Gp_i)}{\Sigma C_i}$$

where C_i is the number of credits for i^{th} course in that semester and Gp_i is the grade points earned by the student for that course.

3.3 Cumulative Grade Point Average (CGPA)

The overall performance of a student at any stage of the program is evaluated by the Cumulative Grade Point Average (CGPA) upto that point of time.

$$\text{Cumulative Grade Point Average} = \frac{\Sigma(C_i \times Gp_i)}{\Sigma C_i}$$

where C_i is the number of credits for i^{th} course in any semester and Gp_i is the grade points earned by the student for that course.

The summation is over all the courses registered by the student and evaluated during all the semesters upto that point of time including the failed courses. The CGPA is rounded off to two decimals. The ranking of the students in a batch at any intermediate or final stage is based on CGPA.

4. Revaluation of Answer Papers

When the semester results are published, in case any student feels aggrieved, he/she can request for revaluation of answer scripts of the end semester examination. For this purpose, the student has to submit a request in the prescribed form to the Controller of Examination within three working days from the publication of results through the Chairman of the Department. The answer paper will be shown to the candidate in the presence of the faculty who valued the answer script and the Chairman concerned. After going through the answer book and the marks awarded, if the candidate desires revaluation, it will be done by the Chairman concerned along with the faculty who valued the answer script. When the revaluation is completed, the results will be published and the revised grade will be awarded to the student. Revaluation will be allowed only for theory based courses.

5. Award of Degree

5.1 Distinction

In order to get the M.Tech. / M C A Degree with Distinction, the candidate has:

To pass all the subjects in the first attempt within the specified period of two/ three years obtaining a CGPA of 8.5 and above.

OR

To pass all the subjects in the first attempt obtaining a CGPA of 8.5 and above completing the program within three / four years (up to one year more) provided officially permitted to break the course.

OR

To pass all the subjects in the first attempt obtaining a CGPA of 8.5 and above and complete the project work before the end of the fifth / seventh semester (up to one semester extension) provided the extension is officially permitted by the CPGP due to administrative reasons.

5.2 First Class

To pass all the subjects in the first attempt within the specified period of two/ three years obtaining a CGPA between 7.00 and 8.49

OR

To pass all the subjects obtaining a CGPA of 8.5 and above taking one semester extra (due to failures etc.)

OR

Asked to redo the project work within one semester extra and obtains a CGPA of 8.5 and above.

5.3 Pass Class

Such of those students who are not covered under 5.1/ 5.2 will be awarded the degree without any class or distinction.

6. Duration, Appeals and Amendments

6.1 Duration

The normal period of completion of the M.Tech. program is 2 years; at most an extension of upto one more year may be permitted. In the case of MCA, the normal period of completion is three years; at most an extension of upto one more year may be permitted.

6.2 Appeals and Amendments

An M.Tech./ MCA student may petition to the CPGP, for a waiver/substitution of any of the M.Tech. Degree requirements. Escalation steps for such petitions consist of forwarding to the Vice Chancellor, whose decision will be final and binding.

7. Attendance

1. Leave shall be availed by students only under unavoidable circumstances. It is mandatory that

students apply in the prescribed form before proceeding on leave. Leave letter recommended by the class advisor shall be submitted to the Chairman of the Department who will normally grant the leave. Unauthorized absence will be treated as breach of discipline. Request for leave for more than three consecutive days on medical ground must be supported by a proper medical certificate. In non-medical cases, requests for leave for more than three consecutive days must be countersigned by the parent/ guardian. Leave granted will not be counted as attendance.

2. Students going on official duties such as representing the School for sports and cultural activities, or presenting papers in seminars will be eligible for "duty leave" on the recommendation by faculty advisor and Chairman of the Department. Duty leave will be counted as equivalent to attendance for administrative purposes limited to five working days per semester, provided the information is sent to all the faculty concerned at least one week in advance.

3. Attendance of the students will be marked by the teacher during every period of a course.

4. Finalization of attendance for every course shall be done three working days before the last instruction day of the semester. Any student failing to secure a minimum of 90% attendance in a course will not be eligible to appear for the end semester examination in that course. The names of students not eligible to appear for the examination will be published.

5. If the attendance of a student falls short of 90% in any course due to continuous absence caused by accident, prolonged illness, or unforeseen circumstances, such case may be considered by the Dean concerned for condonation of absence based on the request of the student supported by required documents and recommendation of the class advisor and Chairman of the Department concerned. However, in such cases, the student must have duly applied for leave in time. The overall attendance of a student in such a case shall not fall below 75%. Condonation will be considered only in the case of those students who have proved themselves to be otherwise regular by attending at least 90% of the class during the semester excluding the period of long leave. Any student who has missed classes for genuine reasons (including on duty leave) will have to submit extra assignments etc (on holidays, late evenings etc) as prescribed by the faculty, to make up for the missed classes. The students will be eligible for the waiver of on duty leave if and only if they complete the extra work load to the satisfaction of the faculty concerned and, the faculty concerened certifies accordingly in the students final leave application.

8. Abbreviations used in this Booklet

Course Classification

FC - Foundation Core
SC - Subject Core
E - Electives
P/F - Pass/Fail

Course Codes

CN - Computational Engineering & Networking
RW - Remote Sensing and Wireless Sensor Networks
CV - Computer Vision and Image Processing
VL - VLSI Design
BM - Biomedical Engineering
PE - Power Electronics
ES - Embedded Systems
CY - Cyber Security
ED - Engineering Design
ME - Manufacturing Engineering
WN - Wireless Networks and Applications
CS - Computer Science and Engineering
CL - Chemical Engineering
TF - Thermal and Fluids Engineering
AT - Automotive Engineering
PR - Power and Energy
NT - Nano Technology
MM - Molecular Medicine
N S - Nanoscience and Technology
CA - Computer Applications
WP - PG Diploma in Wind Power Development
WR - PG Diploma in Wind Resource Assessment
HU - Humanities
MA - Mathematics
SS - Sciences

M.TECH –ENGINEERING DESIGN

Department of Mechanical Engineering

This program is designed to enable an engineering graduate to develop specific capabilities in design, synthesis and analysis of a wide variety of mechanical engineering systems. The program focuses on developing design methodologies which involve high degree of research orientation supplemented with practical insights. Besides core courses (which are mandatory), a variety of electives are also offered to suit the taste of each individual student so that he/she can specialize in a particular area of Engineering Design. The students are periodically assessed by the teachers who are experts in chosen areas of Engineering Design, to ensure quality of education. On the whole, the Masters Program is committed to produce design engineers with excellent creative capabilities and calibre to solve real life problems curtailing to industry requirements, in tune with the objectives envisioned by the University.

CURRICULUM

First Semester

Course Code	Type	Course	L T P	Cr
MA601	FC	Applied Engineering Mathematics	4 0 0	4
ED600	FC	Theory of Elasticity	4 0 0	4
ED601	FC	Fluid Dynamics	3 0 1	4
ED602	FC	Design of Thermal Systems	3 0 0	3
ED650	SC	Optimization Techniques in Engineering	3 0 1	4
ED661	SC	Engineering Design Lab I	0 0 1	1
HU601	HU	Cultural Education*		P/F
			Credits	20

*Non Credit Course

Second Semester

Course Code	Type	Course	L T P	Cr
ED651	SC	Mechanical Vibrations	3 0 1	4
ED652	SC	Selection of Materials and Processes	3 0 0	3
ED653	SC	Finite Element Methods	3 0 0	3
ED654	SC	Mechanical Behavior of Engineering Materials	3 0 1	4
	E	Elective I	3 0 0	3
ED662	SC	Engineering Design Lab II	0 0 2	2
ED663	SC	Engineering Design Lab III	0 0 2	2
			Credits	21

Third Semester

Course Code	Type	Course	L T P	Cr
	E	Elective II	3 0 0	3
	E	Elective III	3 0 0	3
	E	Elective IV	3 0 0	3
ED655	SC	Seminar	0 0 1	1
ED798	P	Minor Project		4
			Credits	14

Fourth Semester

Course Code	Type	Course	L T P	Cr
ED799	P	Dissertation		10
			Credits	10

Total Credits 65

List of Courses

Foundation Core

Course Code	Course	L T P	Cr
MA601	Applied Engineering Mathematics	4 0 0	4
ED600	Theory of Elasticity	4 0 0	4
ED601	Fluid Dynamics	3 0 1	4
ED602	Design of Thermal Systems	3 0 0	3

Subject Core

Course Code	Course	L T P	Cr
ED650	Optimization Techniques in Engineering	3 0 1	4
ED651	Mechanical Vibrations	3 0 1	4
ED652	Selection of Materials and Processes	3 0 0	3
ED653	Finite Element Methods	3 0 0	3
ED654	Mechanical Behavior of Engineering Materials	3 0 1	4
ED655	Seminar	0 0 1	1
ED661	Engineering Design Lab-I	0 0 2	2
ED662	Engineering Design Lab-II	0 0 2	2
ED663	Engineering Design Lab-III	0 0 2	2

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Electives

Course Code	Course	L T P	Cr
	Elective I		
ED700	Continuum Mechanics	3 0 0	3
ED701	Reliability Engineering	3 0 0	3
ED702	Modelling, Simulation and Analysis of Engineering Systems	3 0 0	3
ED703	Advanced Mechanism Analysis and Design	3 0 0	3
	Elective II		
ED704	Theory of Plasticity	3 0 0	3
ED705	Tribology	3 0 0	3
ED706	Product Lifecycle Management	3 0 0	3
ED707	Fracture Mechanics	3 0 0	3
	Elective III		
ED708	Theory of Plates and Shells	3 0 0	3
ED709	Computational Fluid Dynamics	3 0 0	3
ED710	Design for Manufacture and Assembly	3 0 0	3
ED711	Mechanics of Composite Materials	3 0 0	3
	Elective IV		
ED712	Random Vibrations	3 0 0	3
ED713	Computer Aided Product Development	3 0 0	3
ED714	Micro-Electro-Mechanical Systems	3 0 0	3
ED715	Machine Condition Monitoring	3 0 0	3

Project Work

Course Code	Course	L T P	Cr
ED798	Minor Project		4
ED799	Dissertation		10

MA601 APPLIED ENGINEERING MATHEMATICS 4-0-0-4

Introduction to Vectors and Tensors – Scalar, Vector and Tensor Fields – Gradient, Divergence, Curl, and Laplacian of functions. Linear Algebra: Linear system of equations-Linear independence-Solution of linear systems, Newton's method, Quasi-Newton methods. Matrix Eigen value Problems: Standard form, methods for solving Eigen-value problems, solution of characteristic equation, Jacobi's method, Given's method, Householder's method. Complex Analysis: Complex numbers and functions-differentiation and integration-power series and Taylor series. Ordinary Differential Equations: First order ODE, second and higher order linear ODE, series solutions of ODE-power series method-Legendre polynomial-Bessel function. Laplace transform –Transforms of derivatives and integrals – Dirac's delta function. Partial-Differential Equations: Fourier analysis, Variable separation-D'Alembert's solution – Fourier Transforms – Laplace Transforms of partial derivatives – Finite difference methods, Coordinate transformation, elliptic problems, parabolic problems and hyperbolic problems.

TEXT BOOKS/REFERENCES:

1. *Erwin Kreyszig, "Advanced Engineering Mathematics" ,Tenth Edition, John Wiley & sons, 2010.*
2. *Howard Anton and Chris Rorres, "Elementary Linear Algebra", Ninth Edition, John Wiley & Sons, 2000.*
3. *William E. Boyce and DiPrima R.C., "Elementary Differential Equations and Boundary Value Problems", Ninth Edition, Wiley, 2008.*
4. *Lai W.M., Rubin D and Krempl E., "Introduction to Tensor Calculus and Continuum Mechanics", Fourth Edition, Butterworth Heinemann, 1993.*

ED600 THEORY OF ELASTICITY 4-0-0-4

Fundamentals- Stress at point-stress tensor - Analysis of stress and strain – Governing equations. Energy methods – Hooke's law & principle of superposition – Elastic strain energy - reciprocal relation – Maxwell Betti–Rayleigh Reciprocal theorem – First theorem of Castigliano – Expression for strain energy – Theorem of virtual work – Kirchhoff's theorem – second theorem of Castigliano – Engessers theorem Theories of failure – Mohr's theory of failure - stress space – Yield surfaces of Tresca and Von Mises.Formulation of the general elasticity problem-Boundary Value Problems, Boussinesq problem-Three-dimensional problems, torsion and bending of non - circular prismatic bars-Membrane analogy. Straight beams and Asymmetrical bending- Euler – Bernoulli Hypothesis - Centre of flexure- shear stresses in thin walled open section – bending of curved beam – Thick walled cylinder subjected to internal & external pressures – stresses in composite tubes – sphere with purely radial displacements – stresses due to gravitation-rotating disks of uniform thickness – Disks of variable thickness – rotating shafts and cylinder.

TEXT BOOKS/REFERENCES:

1. *Timoshenko S. P. and Goodier J. N., "Theory of Elasticity", Third Edition, McGraw Hill, 1970.*
2. *Sokolnikoff I. S., "Mathematical Theory of Elasticity", Second Edition, McGraw Hill, 1956.*
3. *Den Hartog J. P., "Advanced Strength of Materials", Dover Publications, 1987.*
4. *Fung F.C., "Foundations of Solid Mechanics", Prentice Hall International, 1977.*

5. *Martin H. Saad, "Elasticity: Theory, Application and Numerics", Second Edition, Butterworth Heinemann, 2000.*

ED601 FLUID DYNAMICS 3-0-1-4

Review of vectors and tensors -Lagrangian and Eulerian description, fluid deformation, fluid element strain-material derivative, stress and strain tensors, vorticity, circulation, stream function, velocity potential.Reynolds transport theorem- Conservation laws, constitutive equations, differential equation for conservation of mass, momentum and energy.Exact solutions for laminar flows, creeping flow approximation, laminar boundary layer- similarity solutions- flow over a flat plate and pipes, separation-Introductory vorticity dynamics Turbulent flows: Introduction, characteristic features of turbulence, definitions; Reynolds decomposition, turbulent shear stress and the closure problem, turbulent kinetic energy, Kolmogorov's contributions. Numerical solution of ordinary differential equations: Initial and Boundary value problem- Numerical solution of elliptic, parabolic and hyperbolic equations-Finite difference schemes- Explicit and Implicit methods for transient problems – solution of viscous incompressible flows by stream function-vorticity formulation, primitive variable formulation. Flow in simple geometries and validations. Introduction to CFD Tools-simulation of fluid flow problems using commercial Package.

TEXT BOOKS/REFERENCES:

1. *Kundu P. K. and Cohen I. M., "Fluid Mechanics", Second Edition, Academic Press, 2002.*
2. *Panton R. L., "Incompressible Flow", Second Edition, John Wiley & Sons, 2005.*
3. *Hoffman J. D., "Numerical Methods for Engineers and Scientists", Second Edition, Marcel Dekker, 2001.*
4. *Hoffmann K. A. and Chiang S. T., "Computational Fluid Dynamics", Fourth Edition, Engineering Education System, 2000.*
5. *Ferziger J. H. and Peric M., "Computational Methods for Fluid Mechanics", Third Edition, Springer, 2002.*

ED602 DESIGN OF THERMAL SYSTEMS 3-0-0-3

Introduction and Review of the Basics of Heat Transfer. Equipment Design I: Heat Exchangers and Pipe Networks (?-NTU and LMTD, Physical Design Specifications). Equipment Design 2: Pumps and turbines (Types and Performance Evaluation). System level design principles. Case studies of thermal systems. Design of Thermal Systems from Different Application Areas: Manufacturing process, Electronic cooling, Heat transfer systems, and fluid flow systems.

TEXT BOOKS/REFERENCES:

1. *Frank P. Incropera, David P. DeWitt, Theodore L Bergman and Andrienne S. Lavine, "Fundamentals of Heat and Mass Transfer", Sixth Edition, John Wiley & Sons, 2006.*
2. *Robert W. Fox, Alan T. McDonald and Philip J. Pritchard, "Introduction to Fluid Mechanics", Sixth Edition, John Wiley &Sons, 2006.*
3. *Yogesh Jaluria, "Design and Optimization of Thermal Systems", Second Edition, CRC Press, 2007.*
4. *Wilbert Stoecker, "Design of Thermal Systems", Third Edition, McGraw-Hill, 1989.*

ED650 OPTIMIZATION TECHNIQUES IN ENGINEERING 3-0-1-4

Introduction to Optimization: Engineering application of Optimization – Statement of an optimization problem - Optimal Problem formulation - Classification of optimization problems. Definition of Global and Local minima. Unconstrained Optimization: Optimality Conditions – Algorithms for univariate optimization – Algorithms for multivariate optimization – Convergence of algorithms - Engineering applications of unconstrained algorithms. Lagrange multiplier Theory & Duality: Lagrange multipliers - Kuhn-Tucker Optimality Conditions and sufficiency for convex problems – Lagrangian duality – Saddle point Conditions. Constrained Optimization: Optimality Conditions – Feasible direction methods – Frank-Wolfe algorithm – Gradient Projection – Active set methods - Penalty function methods – Constrained steepest descent method. Modern methods of Optimization: Genetic Algorithms - Simulated Annealing – Tabu search - Ant Colony optimization – Particle Swarm Optimization – Neural-Network based Optimization – Fuzzy optimization techniques. Introduction to Multi-Objective optimization – Classical methods – Pareto Optimality – Use of evolutionary algorithms for solving Multi-Objective optimization problems.

Lab Practice:

Use of programming languages and Matlab to solve optimization problems.

TEXT BOOKS/REFERENCES:

1. *Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall, 2000.*
2. *Rao S. S., "Engineering Optimization Theory and Practice", Fourth Edition, New Age International, 2009.*
3. *Saravanan R., "Manufacturing Optimization through Intelligent Techniques", Taylor & Francis, 2006.*
4. *Ravindran, Phillips and Solberg, "Operations Research Principles and Practice", Wiley India, 2007.*
5. *Hadley G., "Non Linear and Dynamic Programming", Addison Wesley, 1964.*

ED651 ENGINEERING DESIGN LAB-I 0-0-1-1

Solid Modelling and Computational Methods Lab

CAD: Exercises covering sketching, modelling, assembly, interference checking, drafting, generation of BOM. Exercises involving customization of CAD software using VB programming.

Computational Methods: Solving system of linear equations, curve fitting using Matlab, Solving ODE's and PDE's using Matlab toolbox.

ED651 MECHANICAL VIBRATIONS 3-0-1-4

Introduction-Derivation of equation of motion-Free vibration of undamped single degree of freedom systems-Free vibration of damped single degree of freedom systems-Forced response of single degree of freedom systems-Rotating unbalance, support motion, whirling of shafts-Vibration isolation, vibration measuring instruments-Different types of damping-Response of s.d.o.f systems to arbitrary excitation-convolution integral, Fourier transforms method-Free vibration of undamped two degree of freedom systems-formulation and solution of matrix Eigen value problem, natural modes-Elastic and mass coupling, orthogonality of modes, natural coordinates-Response of two-d.o.f systems to harmonic excitation-Damped and

undamped vibration absorbers-Matrix formulation for multi degree of freedom systems, influence coefficients- Undamped free vibration of multi-d.o.f systems, formulation of Eigen value problem-Orthogonality of modal vectors, expansion theorem-Solution of eigen value problem by characteristic determinant-Free vibration of continuous systems, Eigen value problem-Axial vibration of rods, bending vibration of bars-Natural modes of a bar in bending vibration-Introduction to the computational methods, solution of Eigen value problem by matrix iteration, power method using matrix deflation-Introduction to the classical methods for the solution of vibration problems-Rayleigh method, Dunkerleys equation, Lagrange's equation.
Lab: Solving Vibration Problems using MATLAB.

TEXT BOOKS/REFERENCES:

1. *Leonard Meirovitch, "Principles & Techniques of Vibration ", Prentice Hall, 1996*
2. *Thomson T., "Theory of Vibration with Applications", Fifth Edition, Pearson Education, 2003.*
3. *Leonard Meirovitch, "Analytical Methods in Vibrations", MacMillan, 1967.*
4. *Rao S. S., "Mechanical Vibrations", Fifth Edition, Prentice Hall, 2010.*
5. *Graham S. Kelly, "Mechanical Vibrations", Second Edition, McGraw Hill, 2000.*

ED652 SELECTION OF MATERIALS AND PROCESSES 3-0-0-3

Overview of materials properties - mechanical, thermal, oxidation, corrosion and wear. Classification of materials - metals, ceramics, glasses, polymers, elastomers, composites, foams. Basics of materials selection. Design of components - functions, constraints, objectives and free variables. Selection procedure- translation, screening, ranking, supporting information. Multiple constraints and objectives. Design and selection of hybrid materials. Principles of process selection and classification of processes - casting, forging, molding, fabrication, welding, joining, machining, powder processing, composite processing. Illustration of the principles of material/process selection with case studies-fly wheel, heat exchanger, spring, pressure vessel, kiln wall, passive solar heating, connecting rod, gear, gas turbine blade and vane, car wheels, and brake rotor.

TEXT BOOKS/REFERENCES:

1. *Michael F. Ashby, "Materials Selection in Mechanical Design", Third Edition, Elsevier, 2005.*
2. *Michael F. Ashby, Shercliff H. R. and D. Cebon, "Materials: Engineering, Science, Processing and Design", Elsevier Butterworth-Heinemann, 2007.*
3. *Michael F. Ashby and Johnson K. W., "Materials and Design: The Art and Science of Material Selection in Product Design", Butterworth Heinemann, Oxford, UK, 2002.*
4. *ASM Handbook, Vol. 20, "Materials Selection and Design", ASM International, 1998.*

ED653 FINITE ELEMENT METHODS 3-0-0-3

Fundamentals of governing equations in Solid Mechanics and Heat Transfer. Strong form, weak form, Variational formulation, weighted residual method - Galerkin formulation, Formulation of the finite element equations - Element types - Basic and higher order elements-Coordinate systems. Finite elements in Solid Mechanics: analysis of trusses, beams and frames, Plane stress, plane strain and axisymmetric elements, Plate and shell elements.- Isoperimetric formulation. Finite elements in Heat Transfer: Formulations and solution procedures in one-dimensional and two-dimensional problems. Structural dynamics: Formulation - Element mass matrices - Evaluation of Eigen values and Eigen vectors - Natural frequencies and mode shapes - Numerical time integration. Computer implementation of the Finite element method: pre-processing, element calculation, equation assembly, Solving, Post processing – primary and secondary variables. Introduction to computational packages-simple problems.

TEXT BOOKS/REFERENCES:

1. *Rao S. S., "The Finite Element Method in Engineering", Fourth Edition, Elsevier, 2007.*
2. *Jacob Fish and Ted Belytschko, "A First Course in Finite Elements", Wiley Inter Science, 2007.*
3. *David V. Hutton, "Fundamentals of Finite Element Analysis", McGraw Hill, 2005.*
4. *Daryl L. Logan, "A First Course in the Finite Element Method", Fourth Edition, Cengage Learning, 2007.*
5. *Zienkiewicz O.C, Taylor R.L. and Zhu J.Z., "The Finite Element Methods, Vol 1-The Basic Formulation and Linear Problems", Sixth Edition, Butterworth Heinemann, 2005.*

ED654 MECHANICAL BEHAVIOR OF ENGINEERING MATERIALS 3-0-1-4

Structure of materials, Defects, Types of Mechanical Behavior, Physical Mechanisms controlling behavior. Elasticity: Stress, strain, compliances and stiffness tensors, Generalized Hook's law application to crystals, Anisotropic behavior, visco-elasticity, Continuum Plasticity: True stress-strain curve necking criterion, Yield criteria and locus, Isotropic and kinematic hardening, plastic stress-strain relations. Micro structural aspects of plasticity: Theoretical shear strength, Dislocations and Burger's vector, Elastic properties and energy of dislocations, Forces between dislocations, Partial dislocation and stacking fault, Dislocation-dislocation interactions, The peierls-Nabarro Stress, Origin and multiplication of dislocations, Slip and slip system, Slip plane rotation, Twinning and twin geometry. Strengthening mechanisms: Work hardening, Grain boundary strengthening, solid solution strengthening, Point defect-dislocation interaction energy, Yield point phenomenon, Precipitation hardening, Dislocation-precipitate interactions. Fracture: Fracture in ceramics, polymers and metals, Linear Elastic fracture mechanics, Stress intensity factor, Fracture toughness, Crack-tip plasticity-plastic zone, K-dominance, Elasto-plastic fracture mechanics, Measurement and Standards. Fatigue: S-N curves, Fatigue design approaches, HCF and LCF, Life cycle prediction, Fatigue crack growth, Fatigue in metals, ceramics and polymers.

TEXT BOOKS/REFERENCES:

1. *Hertzberg R. W., "Deformation and Fracture Mechanics of Engineering Materials", John Wiley & Sons, 1995.*
2. *Dieter G. E., "Mechanical Metallurgy", McGraw-Hill, 1988.*
3. *Marc Meyers and Chawla, "Mechanical Behavior of Materials", Meyers, 2007.*
4. *Dowling N. E., "Mechanical Behavior of Materials Engineering - Methods for Deformation, Fracture and Fatigue", Third Edition, Prentice Hall, 2007.*
5. *Suresh,S., "Fatigue of Materials", Second Edition, Cambridge University Press, 1998.*

ED662 ENGINEERING DESIGN LAB-II 0-0-2-2

Computer Aided Engineering Lab
Finite Element Analysis :
Exercises covering structural analysis, dynamic analysis using and thermomechanical coupled analysis FEA packages– Finite element modelling of metal forming and metal cutting operation.
Computational Fluid Dynamics:
Computational Fluid Dynamic analysis of steady, unsteady and turbulent flows
Mechanism Modelling and Analysis:
Design synthesis of simple mechanisms like sewing machine, grass cutter etc. using synthesis tools. Force analysis of simple mechanisms.

ED663 ENGINEERING DESIGN LAB-III 0-0-2-2

Experimental Engineering Lab.
Design of Experiments:
Introduction to Design of Experiments, Factorial Design ,Response surface Methods.
Practical Stress Analysis:
Verification of stresses under mechanical loading using strain gauges, Calibration of torsional load cell, Modal testing and extraction of modal parameters.
Machine Condition Monitoring:
Machine condition monitoring studies using FFT analyzer and virtual instrumentation tools.

ED665 SEMINAR 0-0-1-1

The student in consultation with the faculty advisor has to select a topic related to Engineering Design, write a paper and present it.

ED700 CONTINUUM MECHANICS 3-0-0-3

Introduction to continuum mechanics: Vectors and tensors, Stress Principles, Kinematics of Deformation and Motion, Fundamental Laws and Equations: Continuum models in solid Mechanics: Linear Elasticity: Elasto-Statistics and Elasto-Dynamics Nonlinear elasticity: Elasto-Plasticity, Visco-elasticity, Hypo- and Hyper –elasticity Continuum models in heat Transfer: Conduction and Radiation, Nonlinear models, Transport phenomena problems: Momentum, Energy, and Mass transport.

TEXT BOOKS/ REFERENCES

1. *Gerhard A. Holzapfel, "Non-linear Solid Mechanics-A Continuum Approach for Engineering", Wiley, 2000.*
2. *Morton E Gurtin, Eliot Fried and Lallit Anand, "The Mechanics and Thermodynamics of Continua", Cambridge, 2009.*
3. *Martin H Sadd, "Elasticity: Theory, Application and Numerics", Second Edition, Buterworth Heinemann, 2000.*
4. *Michael Lai W, David Rubin and Erhard Krempl, "Introduction to Tensor Calculus and Continuum Mechanics", Fourth Edition, Butterworth Heinemann, 2010.*
5. *Roger Temam and Alian Miranville, "Mathematical Modeling in Continuum Mechanics", Cambridge University Press, 2005.*

ED701 RELIABILITY ENGINEERING 3-0-0-3

Concept and definition of reliability-reliability mathematics-failure distributions, hazard rate function; bathtub curve, hazard models-exponential, Rayleigh, Weibull, Normal, Lognormal distributions-MTTF, MTBF, median time to failures-failure models-Reliability of systems-serial and parallel configurations-mixedconfiguration-K-out-of-n-systems-redundancy-types-stand by systems-Reliability of complex configurations-event-space method-path tracing and decomposition methods-use of tie sets and cut sets-three-state devices-Markov analysis-physical reliability models-random stress and random strength-static models-dynamic models-periodic loads-random loads-Design for reliability-Reliability allocation-derating-maintainability-Design for maintainability-Availability, maintenance and spare provisioning-failure data analysis-reliability testing-types-test time calculations-burn-in, acceptance testing for reliability-identifying failure distribution-parameter estimation.

TEXT BOOKS/ REFERENCES:

1. *Charles Ebeling, "An Introduction to Reliability and Maintainability Engineering", Tata McGraw Hill, 2000.*
2. *Richard E. Barlow, Frank Proschan, "Mathematical Theory of Reliability", SIAM, 1996.*
3. *Massimo Lazzaroni,"Reliability Engineering: Basic Concepts and Application in ICT", Springer, 2011.*
4. *Alessandro Birolini, "Reliability Engineering, Theory and Practice", Sixth Edition, Springer, 2010.*
5. *Srineth L.S, "Reliability Engineering", Fourth Edition, East West Publishers, 2005.*

ED702 MODELLING, SIMULATION AND ANALYSIS OF ENGINEERING SYSTEMS 3-0-0-3

Introduction to linear systems, principle of super position-Modelling of engineering systems-mechanical, electrical, fluid, thermal and mixed discipline systems-Free, forced and transient response of first and second order systems-Solution of differential equation using Laplace Transforms-Time domain and Frequency domain analysis-State space representation-System characteristics from state space representation-Solving the state equations-Stability criterion through the state transition matrix-Control system design in state space-Linear optimal control.

TEXT BOOKS/REFERENCES:

1. *Philip D. Cha, James J. Rosenberg and Clive L. Dym, "Fundamentals of Modelling and Analysis of Engineering Systems", Cambridge University Press, 2000.*
2. *Woods Robert L. and Lawrence Kent L., "Modelling and Simulation of Dynamic Systems", Prentice Hall, 1997.*
3. *Ashish Tiwari, "Modern Control Design with MATLAB and SIMULINK", John Wiley, 2002.*

ED703 ADVANCED MECHANISM ANALYSIS AND DESIGN 3-0-0-3

Review of fundamentals of kinematics - Mobility Analysis - Formation of one D.O.F. multiloop kinematic chains, Network formula - Gross motion concepts. Computer aided kinematic analysis - Euler parameters - Co-ordinates of a body, Identities with Euler parameters. Spatial Kinematics - Relative constraints between two vectors - Relative constraints between two bodies - Concept of equivalent mechanisms. Synthesis of mechanisms - Three position and four position synthesis - Chebyshev spacing of precision points - Computer aided synthesis. Curvature theory – Velocities and accelerations –

Review of instant centre concept - Euler – Savary equations - Bobillier theorem - Cubic of stationary curvature - Ball's point. Review of basic concepts in dynamics - Planar dynamics - Equations of motion - System of equations of motion - Computer assisted dynamic force analysis of planar mechanisms – Kinematic Analysis of Spatial RSSR mechanism - Denavit - Hartenberg Parameters - Forward and Inverse Kinematics of Robotic Manipulators - Study and use of mechanism - software packages.

TEXT BOOKS/REFERENCES:

1. *Parviz Nikravesh, "Computer Aided Analysis of Mechanical System", Prentice Hall, 1988.*
2. *Sandor G. N. and Erdman A. G., "Advanced Mechanism Design: Analysis and Synthesis", Vol.2, Prentice Hall, 1984.*
3. *Chung-Ha Suh and Charles Radcliffe, "Kinematics and Mechanism Design", John Wiley & Sons, 1978.*
4. *Kenneth J. Waldron and Gary L.Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley & Sons, 1999.*
5. *Rao V. Dukkipati, "Spatial Mechanisms: Analysis and Synthesis", CRC Press, 2001.*

ED704 THEORY OF PLASTICITY 3-0-0-3

Mathematics-Notation-Tensors-Vector and tensor calculus, curvilinear coordinates. Strain Analysis: Displacement, Deformation (strain Tensor), principal strains, Mohr circle of strains, compatibility, Plane strain, Displacement boundary conditions. Stress Analysis: Stress (Stress tensor), Mohr's circle of stress, Plane stress, Stress boundary conditions Constitutive Relations: First and Second Laws of TD, Elasticity, Inelasticity, Visco plasticity, Rate-Independent plasticity, Yield criteria, Flow rules, Hardening rules, Advanced models, Bounding-surface plasticity. Constrained plastic flow: Hollow cylinders and hollow spheres subject to internal and external pressures, Cavity expansion, Torsion, Bending. Limit Analysis: Plastic dissipation, Drucker's postulate, Lower bound theorem, Upper Bound theorem, Applications, numerical implementation.

TEXT BOOKS/REFERENCES:

1. *Lubliner J., "Plasticity Theory", MacMillan, New York, 1990.*
2. *Dally J.W. and Riley, W.F., "Experimental Stress Analysis", Third Edition, McGraw- Hill, 1991.*
3. *Fung Y. C., "A First Course in Continuum Mechanics", Second Edition, Prentice Hall, 1977.*
4. *Hill R., "The Mathematical Theory of Plasticity", Clarendon Press, 1998.*
5. *Simo J. C. and Hughes T. J. R., "Computational Inelasticity", Springer Verlag, 1998.*

ED705 TRIBOLOGY 3-0-0-3

Engineering Surfaces - surface topography-Analysis of surface roughness-Conformal and non-conformal surfaces-Greenwood and Williamson Model-Contact mechanics, Dry contacts-Friction, Modern theories of friction-Stick-Slip Phenomenon-Liquid-Mediated contacts-Wear, Effect of surface roughness, friction, and sliding speed on wear-Ferrography - Oil Analysis Program - Basic equations of Flow, Navier-Stokes equation, Generalized Reynolds's equation-Hydrodynamic lubrication-Boundary lubrication-Bearing materials-Hydrodynamic real (finite) bearings-Design considerations in journal and thrust bearings-Hydrodynamic instability-Hydrodynamic and hydrostatic gas bearings-Idealized slider and journal bearings-Oil flow and Thermal analysis of bearings-Bearing selection and design-Dynamically loaded bearings-Squeeze film bearings.

TEXT BOOKS/REFERENCES:

1. *Majumdar B. C., "Tribology of Bearings", A. H. Wheeler and Company, 1986.*
2. *Bharat Bhushan, "Introduction to Tribology", John Wiley & Sons, 2002.*
3. *Moore and Desmond. F., "Principles and Applications of Tribology", Pergamon Press, 1975.*
4. *Dudley D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley & Sons, 1984.*
5. *Johnson K. L., "Contact Mechanics", Cambridge University Press, 1987.*

ED706 PRODUCT LIFECYCLE MANAGEMENT 3-0-0-3

Introduction to Product life cycle - PLM- PDM concepts -present market constraints - need for collaboration – Object oriented programming concepts - internet and developments in server - client computing. Components of a typical PLM / PDM setup - hardware and software - document management - creation and viewing of parts and documents- version control -case studies. Configuration management: Base lines - product structure - configuration management – Effectivity - case studies. Creation of projects and roles - life cycle of a product-life cycle management - automating information flow-workflows - creation of work flow templates -life cycle - work flow integration - case studies. Change management: Change issue- change request-change investigation- change proposal - change activity - case studies. Generic products and variants: Data Management Systems for FEA data - Product configuration - comparison between sales configuration and product configuration -generic product modeling in configuration model - use of order generator for variant creation-registering of variants in product register-case studies. Implementation issues and best practices.

TEXT BOOKS/ REFERENCES:

1. *Kevin Otto and Kristin Wood, "Product Design", Pearson, 2001.*
2. *Daniel Amor, "The E-Business Revolution", Prentice Hall, 2000.*
3. *David Bed Worth, Mark Henderson and Phillip Wolfe, "Computer Integrated Design and Manufacturing", McGraw Hill, 1991.*
4. *Terry Quatrain., "Visual Modeling with Rational Rose and UML", Addison Wesley, 1998.*

ED707 FRACTURE MECHANICS 3-0-0-3

Introduction and review of solid mechanics, plane elasticity- In-plane and out-of-plane problems-Airy's stress function-plate with a circular hole, elliptic hole. Fatigue-Failure of uncracked solids, stress-life approach, strain-life approach, Effect of mean stress, Miner's rule, Damage rule for irregular loads. Linear Elastic Fracture mechanics: Energetics of fracture, Griffith's energy balance, strain energy release rate, stability of crack growth-R curve, Eigen expansion for wedges and notches, stress ,displacement field at the crack tip for Mode I and Mode II, Stress Intensity Factor(SIF), Mode III fields, Westergaards function, Relationship between K and G, direction of crack propagation, mixed mode fracture, SIF for various geometries, Crack-Tip plasticity, Correction factor for plasticity effects, Experimental determination of Kc. Elastic-Plastic Fracture mechanics: J- contour integral, Relation between J-integral and CTOD, crack growth resistance curves, constraint effect in fracture, Experimental measurement of J.Fatigue -growth of an initial crack, Fatigue crack growth analysis, Paris law, fatigue life, variable amplitude loading. Fracture mechanics in metals: Ductile fracture, cleavage fracture, ductile-brittle transition.

TEXT BOOKS/REFERENCES:

1. *Anderson T. L., "Fracture Mechanics: Fundamentals and Applications", Second Edition, CRC Press, 1995.*
2. *Suresh S., "Fatigue of Materials", Second Edition, Cambridge University Press, 1998.*
3. *Barsom J.M and Rolfe S.T., "Fracture and Fatigue Control in Structures", Second Edition, Englewoods Cliffs, Prentice Hall,1987.*
4. *Broek D., "Elementary Engineering Fracture Mechanics", Fourth Edition, Martinus Nijhoff, 1987.*
5. *Knott J.K., "Fundamentals of Fracture Mechanics", Third Edition, Butterworth Heinemann, 1993.*

ED708 THEORY OF PLATES AND SHELLS 3-0-0-3

Introduction - Formulation of governing equations and associated boundary conditions by equilibrium and energy methods, Rectangular plates - Solution of equation by double and single series, Circular plates - Symmetric and unsymmetric loading cases, Continuous Plates, Plates with various plan forms, Plates with variable flexural rigidity, Plates on elastic foundation. Numerical and Approximate Methods - finite difference method - finite element method, energy methods and other variational methods. Introduction, Theory of Surfaces - first and second fundamental forms - principal curvatures, Formulation of governing equations in general orthogonal curvilinear coordinates based on classical assumptions - various shell theories, Membrane theory - governing equations - shells of revolution - application to specific geometric shapes - ax symmetric and non-axisymmetric loading cases. General theory of shells - governing equations and associated boundary conditions for specific geometry of shells (cylindrical, conical and spherical shells) - classical solutions - finite difference and finite element methods applied to shell problems.

TEXT BOOKS/REFERENCES:

1. *Vardhan T.K. and Bhaskar,K., "Analysis of Plates: Theory and Problems", John Wiley & Sons, 1999.*
2. *Timoshenko S. and Woinowsky Krieger S., "Theory of Plates and Shells", McGraw- Hill, 1959.*
3. *Chandrashekhara K., "Theory of Plates", Universities Press, 2001.*

ED709 COMPUTATIONAL FLUID DYNAMICS 3-0-0-3

Introduction: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description. Classification and Overview of Numerical Methods: Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods. Discretisation techniques using finite difference methods: Taylor-Series and control volume formulations. One dimensional steady state diffusion problems; discretization technique. Solution methodology for linear and non-linear problems: Point-by-point iteration, TDMA. Two and three dimensional discretization. Discretization of unsteady diffusion problems: Explicit, Implicit and Crank-Nicolson's algorithm; stability of solutions.One dimensional convection-diffusion problem: Central difference scheme, Discretization based on analytical approach (exponential scheme). Hybrid and power law discretization techniques. Higher order schemes (QUICK algorithm). Discretization of incompressible flow equations. Pressure based algorithm: SIMPLE, SIMPLER etc.Introduction to turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.CFD simulation of flow problems using commercial packages.

TEXT BOOKS/REFERENCES:

1. *Patankar S.V., "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 1980.*
2. *Anderson D.A., Tannehill J.C and Pletcher R.H., "Computational Fluid Mechanics and Heat Transfer", Second Edition, Taylor & Francis, 1997.*
3. *Ferziger J.H. and Peric M., "Computational Methods for Fluid Dynamics", Third Edition, Springer, 2002.*
4. *Versteeg H.K. and Malalasekera W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson Education, 2007.*
5. *Date A.W., "Introduction to Computational Fluid Dynamics", Cambridge University Press, 2005.*

ED710 DESIGN FOR MANUFACTURE AND ASSEMBLY 3-0-0-3

DFM approach, DFM guidelines, Standardization, Group technology, value engineering, development and evaluation of alternative solutions, Poke – Yoke principles. Tolerance analysis – process capability, process capability metrics, cost aspects, geometric tolerances, cumulative effect of tolerances, interchangeable and selective assembly. Control of axial play – secondary machining operations, laminated shims. Datum systems – grouped datum systems – geometric analysis and applications. True position theory – true position tolerancing, zero true position tolerance, functional gauges, paper layout gauging, compound assembly. Form design of castings and weldments – Redesign of castings – redesigning cast members using weldments. Tolerance charting technique, centrality analysis – computer aided tolerance charting. Design for machining. Design features to facilitate machining – functional and manufacturing datum features, redesign for manufacture. Environmental objectives – Global issues – Regional and local issues– Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.

TEXT BOOKS/ REFERENCES:

1. *Boothroyd G., Dewhurst P. and Knight W., "Product Design for Manufacture and Assembly", Second Edition, Marcel Dekker, New York, 2002.*
2. *Harry Peck, "Designing for Manufacture", Pitmin Publications, 1983.*
3. *Spotts M. F., "Dimensioning and Tolerance for Quantity Production", Prentice Hall, 1983.*
4. *Boothroyd G., "Design for Assembly: The Road to Higher Productivity", Assembly Engineering, 1982.*
5. *Creveling C. M., "Tolerance Design - A Hand Book for Developing Optimal Specifications", Prentice Hall, 1997.*

ED711 MECHANICS OF COMPOSITE MATERIALS 3-0-0-

Composite materials and its characteristics-Analysis of an orthotrop lamina-Analysis of laminated composites-Fracture mechanics Determination of strain energy release rate-Manufacturing Proc ase Testing of Composites-Stress analysis - interlaminar stresses a free edge effects-Failure Criteria-Whitness nuismer failure criter Vibration and stability analysis- Introduction to Design of Compos Structures -Introduction to Structural -Design and Analysis

mechanically fastened joints- Optimization Concepts –Fatigue in Composites-Effects of holes in Laminates –Transverse shear effects-Post curing shapes of Unsymmetric Laminates-Environmental Effects on Composite Materials-Study of Hygrothermic effects on laminates-Quality control and Characterisation of Composite-Non Destructive testing on Composites-Recycling of Composites –Primary and Secondary Recycling of Composites.

TEXT BOOKS/REFERENCES:

1. *Mallick P. K., "Fiber Reinforced Composite Materials - Manufacturing and Design", Marcel Dekker, 1993.*
2. *Robert M. Jones, "Mechanics of Composite Materials", Second Edition, Taylor and Francis,1999.*
3. *Halpin J. C., "Primer on Composite Materials Analysis", Technomic, 1984.*
4. *Mallick P. K. and Newman S., "Composite Materials Technology - Processes and Properties", Hansen, 1990.*
5. *Agarwal B. D. and Broutman L. J., "Analysis and Performance of Fibre Composites", John Wiley & Sons, 1990.*

ED712 RANDOM VIBRATIONS 3-0-0-3

Concept of probability - Theory of random variables - Probability structure of random variable - Stationary and non-stationary random process - Calculus of random process - Spectral decomposition of random process - Gaussian, Poisson and Markov process - Response of single degree of freedom, multi degree of freedom and continuous systems to random excitation - Failure modes in random vibration-level crossing statistics-First excursion failure-Rice formula - Fatigue failure - Palmgren – Miner cumulative damage law - Application to civil, mechanical and ocean structures - Introduction to non linear random vibration.

TEXT BOOKS/REFERENCES:

1. *Nigam N.C. and S. Narayanan, "Applications of Random Vibrations", Springer-Verlag, 1994.*
2. *Lin Y. K. and Cai G. K., "Probabilistic Structural Dynamics", McGraw Hill, 1995.*
3. *Crandall S. H., "Random Vibrations - Vol. I & II", MIT Press, 1963.*
4. *Newland D. E., "An Introduction to Random Vibrations and Spectral Analysis", Longman, 1984.*

ED713 COMPUTER AIDED PRODUCT DEVELOPMENT 3-0-0-3

Introduction to New Product design – Creativity and Innovation - concept design – parametric sketching – constraints- Feature based modeling - synchronous technology – contemporary software – Kernel and graphics engine – Hardware requirements - data exchange formats. Computers in Design — Assembly modeling – creation of BOM –issues in large assemblies - associative features – Sheet metal components, nesting and development – plastic parts with draft and shrinkage allowance – Reverse engineering of components – tolerance analysis – check for interferences and mass property calculations. Computers applications in tool design – mould design – jigs and fixtures design – mechanism design and analysis – Rapid tooling – Computer aided inspection. Computers in Design Productivity – customisation using various software like visual basic, pro/program, script, LISP etc. to write applications like design of shafts, gears etc. Managing product design data – version control – library creation – catalogue making – standardization for design – collaborative design among peer groups – design optimization for geometry - Design check, approval and validation. – Introduction to design patenting rules.

TEXT BOOKS/ REFERENCES:

1. *Robert G. Cooper and Scott J. Edgett, "Product Innovation and Technology Strategy", Product Development Institute, 2009.*
2. *Fuh J.Y.H., "Computer-Aided Injection Mold Design and Manufacture", Marcel Dekker, 2004.*
3. *Chua C. K., Leong K. F, Lim C. S., "Rapid Prototyping: Principles and Applications", Third Edition, World Scientific Publishing Co. Pvt. Ltd., 2010.*
4. *Rao P.N., "CAD/CAM: Principles and Applications", Second Edition, Tata McGraw- Hill, 2004.*

ED714 MICRO-ELECTRO-MECHANICAL SYSTEMS 3-0-0-3

Introduction: MEMS and Microsystems, Typical MEMS and microsystem products, evolution of micro-fabrication. Mechanics for Micro System Design: Static bending of thin plates, mechanical vibration – micro accelerometer- design theory- resonant micro sensors, thermo mechanics, and fracture mechanics- interfacial fracture mechanics, Finite element stress analysis. Thermo-fluid Engineering: Basic Equations in Continuum Fluid Dynamics, Fluid flow in Sub micrometer and nanoscale, Heat Conduction - multilayered thin films-solids in sub micrometer scale. Scaling Laws: Geometry, dynamics, electrostatic forces, electromagnetic forces, fluid mechanics and heat transfer. Micro System Fabrication Processes: Photolithography, Chemical vapour Deposition, Physical vapour Deposition, Etching- chemical, plasma, Bulk and Surface Micro Manufacturing, LIGA. Micro system packaging- levels- die preparation, surface bonding, wire bonding, sealing, -assembly of Microsystems- packaging materials, signal mapping and transduction.

TEXT BOOKS/REFERENCES:

1. *Tai–Ran Hsu, "MEMS and Microsystems Design and Manufacturing", Tata McGraw Hill, 2002.*
2. *Marc J. Madou, "Fundamentals of Microfabrication", Second Edition, CRC Press, 2002.*
3. *Mohamed Gad-el-Hak, "The MEMS Handbook", CRC Press, 2002.*

ED715 MACHINE CONDITION MONITORING 3-0-0-3

Introduction and Background: Condition Monitoring Methods, Vibration Measurement and Analysis, Benefits of Vibration Analysis, Vibration Transducers, Vibration Signals from Rotating and Reciprocating Machines, Infrared Thermography, Oil Analysis and Tribology, Ultrasonics, Motor Current Analysis. Signals and systems: Introduction to signal processing, sampling and aliasing, Nyquist sampling theorem, analog to digital conversion, Fourier transform and Fourier series, discrete Fourier transform, properties, fast Fourier transform, Filtering: FIR and IIR filters implementation. Overview of wavelet transform: Continuous wavelet transform, discrete wavelet transform, wavelet packets, Applications in denoising and feature extraction.Condition monitoring of gearboxes, Condition Monitoring of ball/roller bearings, Condition monitoring in IC Engines, Condition monitoring in electrical machines. Monitoring and Control of Machining, Precision Manufacturing Process Monitoring with Acoustic Emission, Tool Condition Monitoring. Fault-Trending and Prognostics: Trend Analysis, Advanced Prognostics, Data-Driven Models and Hybrid Models.

TEXT BOOKS/REFERENCES:

1. *Robert Bond Randall, "Vibration-Based Condition Monitoring: Industrial, Aerospace and Automotive Applications", John Wiley & Sons, 2011.*
2. *George Vachtsevanos, Frank L. Lewis, Michael Roemer, Andrew Hess and Biqing Wu., "Intelligent Fault Diagnosis and Prognosis for Engineering Systems", Wiley. 2006.*
3. *John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing Principles, Algorithms, Applications", Fifth Edition, PHI, 2003.*
4. *Stephane Mallat, "A Wavelet Tour of Signal Processing: The Sparse Way", Third Edition, Academic Press, 2009.*
5. *Kihong Shin and Joseph K. Hammond, "Fundamentals of Signal Processing for Sound and Vibration Engineers", John Wiley & Sons Ltd., 2008.*

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