M.Tech in Mechanical Engineering (Specialization: *Applied Mechanics*)

Department of Mechanical Engineering

Tezpur University

Curriculum

Semester	Course detail SN	Code	Title	L	T	P	CH	Cr	Total Credits
I	1	ME-501	Advanced Solid Mechanics	3	1	0	4	4	22
	2	ME-541	Advanced Fluid Mechanics	3	1	0	4	4	
	3	ME-561	Experimental Methods for Solids and Fluids	3	0	2	7	5	
	4	xx-xxx	Open Elective I					3	
	5	xx-xxx	Programme Elective I					3*	
	6	xx-xxx	Programme Elective II					3*	
II	1	ME-502	Finite Element Methods	3	1	0	4	4	21
	2	ME-572	Advanced Engineering Materials	3	0	0	3	3	
	3	ME-592	Term Paper	0	0	0	0	2	
	4	xx-xxx	Open Elective II					3	
	5	xx-xxx	Programme Elective III					3	
	6	xx-xxx	Programme Elective IV					3*	
	7	xx-xxx	Programme Elective V					3*	
III	1	ME-615	MTech Thesis Part I					12	12
IV	2	ME-616	MTech Thesis Part II					12	12
Total	**14**	**Minimum credit to be completed for award of the degree**							**67**

** Minimum credits are shown against the elective courses. The overall credit, however, may vary with the actual credits of opted elective courses (credits of other courses are fixed as shown).*

Syllabus

ME-501: Advanced Solid Mechanics **L-T-P-CH-CR: 3-1-0-4-4**

Analysis of stress - introduction, Cauchy's formula, principal stresses, stress invariants, three-dimensional Mohr's circle, octahedral stresses, hydrostatic and deviatoric stresses, differential equations of equilibrium in rectangular and polar coordinates, stress boundary conditions, plane stress and plane stress problems;

Analysis of strain - introduction, definitions of normal and shear strains, principal strains, strain invariants, plane strain in rectangular and polar coordinates, compatibility conditions;

Stress-strain relations for linearly elastic bodies - generalized Hooke's law, relations between elastic constants;

Energy methods - introduction, principle of superposition, elastic strain energy and complementary energy, reciprocal relations, Maxwell-Betti theorem, Castigliano's theorem, principle of virtual work, statically indeterminate structures, Kirchoff's theorem;

Bending of beams - bending of symmetrical and unsymmetrical straight beams, shear stresses in beams, shear center and shear flow, curved beam; Torsion - torsion of circular, elliptical and rectangular bars, thin walled sections; Axisymmetric problems - thick and thin walled cylinders, composite tubes, rotating disks; Elastic stability - Euler's buckling load, beam column, eigenvalue problem;

Assignment and mini-project.

Textbooks

1. Srinath, L.S. *Advanced Mechanics of Solids* (Tata McGraw-Hill, New Delhi, 2009)
2. Raymond, P. *Solid Mechanics in Engineering* (Willey, 2001)

References

1. Sadd, M.H. *Elasticity: Theory, Applications, and Numerics* (Academic Press, 2009)
2. Budynas, R.G. *Advanced Strength and Applied Stress Analysis* (McGraw Hill, 1999)
3. Boresi, A.P. and Schmidt, R.J. *Advanced Mechanics of Materials* (John Willey & Sons, 2003)

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ME-502: Finite Element Methods L-T-P-CH-CR: 3-1-0-4-4

Introduction, basic concept, comparison with finite difference method; Variational methods - calculus of variation, Rayleigh-Ritz and Galerkin methods;

One-dimensional problems - formulation by different approaches, derivation of elemental equations, assembly, solutions and post-processing, bending of beams, analysis of truss and frame, other problems of solid mechanics, fluid mechanics and heat transfer;

Two-dimensional problems - modeling of single variable problems, triangular and rectangular elements, applications in solid mechanics, fluid mechanics and heat transfer;

Numerical considerations - numerical integration, error analysis, mesh refinement;

Plane stress and plane strain problems; Bending of plates; Eigenvalue and time dependent problems; Discussion about preprocessors, postprocessors;

Application of commercial software packages; Assignment and mini-project.

Textbooks

1. Chandrupatla, T.R. and Belegundu, A.D. *Introduction to Finite Elements in Engineering*, Vol. 1 (Prentice Hall, 2002)
2. Bathe, K.J. Finite Element Procedures in Engineering Analysis (Prentice Hall, 1996)

References

1. Reddy, J.N. An introduction to the Finite Element Method (McGraw-Hill, 2006)
2. Cook, R.D., Malkus, D.S. and Plesha, M.E. *Concepts and Applications of Finite Element Analysis* (Wiley, 2007)
3. Hughes, T.J.T. *The Finite Element Method* (Dover Publications, 2000)
4. Zienkiewicz, C. and Taylor, R.L. *The Finite Element Method* (McGraw-Hill, 1989)

ME-541: Advanced Fluid Mechanics L-T-P-CH-CR: 3-1-0-4-4

Preliminary concepts on fluid, body force, surface force, scalar and vector fields, Eulerian and Lagrangian description of flow, motion of fluid element - translation, rotation and deformation;

Vorticity and strain-rate tensors, integral and differential forms of governing equations - mass, momentum and energy conservation equations, stress tensor, principle of local stress equilibrium;

Cauchy's equations of motion, transport theorems, constitutive equations, Stokes law of viscosity, Navier-Stokes equations and their exact solutions, theory of hydrodynamic lubrication, flow between two concentric rotating cylinders;

Stokes first and second problems, Laminar boundary layer, Prandtl's boundary layer theory, similarity solution, momentum integral equation for boundary layer, Karman Pohlhausen approximation;

Hydrodynamic stability - stability in elementary flow fields, introduction to turbulent flow, review of compressible flow - isentropic flow, flow with area change, flow with heat transfer, flow with friction, sonic flow, supersonic flow, shock waves, Prandtl Mayor's equation; Assignment and mini-project.

Textbooks

1. Muralidhar, K. and Biswas, G. *Advanced Engineering Fluid Mechanics*. (Narosa Publishing House, 2005)
2. Binder, R.C. *Advanced Fluid Dynamics* (Prentice Hall,1958)

References

1. Schlichting, H. *Boundary Layer Theory* (McGraw-Hill, 1979)
2. White, F.M. *Viscous Fluid Flow* (McGraw-Hill, 2011)
3. Munson, B.R., Young, D.F. and Okiishi, T.H. *Fundamental of Fluid Mechanics* (John Wiley & Sons, 2002)
4. Panton, R.L. *Incompressible Flow* (Wiley, 2005)
5. Anderson, J.D. *Modern Compressible Flow with Historical Perspective* (McGraw-Hill, 1990)

ME-561: Experimental Methods for Solids and Fluids L-T-P-CH-CR: 3-0-2-7-5

Theory and experimentation in engineering - problem solving approaches, types of engineering experiments, computer simulation and physical experimentation;

Generalized measuring system, types of inputs, analog and digital signals, standards, calibration and uncertainty, measurement system - performance characteristics;

Analysis of experimental data – error analysis, uncertainty analysis, data reduction techniques, statistical analysis of data, probability distributions and curve fitting;

Material properties, experimental measurement of force, torque, stress, strain, and displacement in solids and structures, photoelasticity and strain gauges, investigation of the microstructure of materials, digital image correlation technique;

Measurement of pressure, flow measurement and flow visualization, flow velocity measurement, measurement of temperature, optical methods of measurements, hot wire anemometry, hot film anemometry, laser Doppler anemometer, instrumentation in two-phase flows, particle image velocimetry technique;

Textbooks

1. Srinath, L.S. and Raghavan, M.R. *Experimental Stress Analysis* (Tata McGraw-Hill, 1984)
2. Wheeler, A.J. and Ganji, A.R. *Introduction to Engineering Experimentation* (Prentice Hall, 2003)
3. Clemens, N.T. and Tropea, C. *Experiments in Fluids* (Springer, 1983)
4. Goldstein, R.J. *Fluid Mechanics Measurements* (Taylor & Francis, 1996)

References

1. Dally, J.W. and Riely, W.P. *Experimental Stress Analysis* (McGraw-Hill, 1991)
2. Hendry, A.W. *Elements of Experimental Stress Analysis* (Pergamon Press, 1977)
3. Beckwith, T.G., Marangoni, R.D. and Lienhard, J.H. *Mechanical Measurements* (Prentice Hall, 2006)
4. Doeblin, E.O. *Measurement Systems - Application and Design* (McGraw-Hill, 1989)
5. Holman, J. Experimental Methods for Engineers (McGraw-Hill, 2000)
6. Doeblin, E.O. *Engineering Experimentation* (McGraw-Hill, 1995)

ME-572: Advanced Engineering Materials L-T-P-CH-CR: 3-0-0-3-3

Advanced materials for engineering applications, engineering materials - metals, polymers, composites and ceramics; Structure-property correlation - role of crystal structure, substructure and microstructure on material properties;

High performance structural metallic alloys and their applications, surface engineering of materials and their applications;

Piezoelectric materials, shape memory alloys, smart materials and composite materials and their applications;

Micro-electro-mechanical systems (MEMS) - characteristics of materials for MEMS applications and manufacturing techniques for MEMS components;

Materials for high temperature applications - various alloys and composites, diffusion bond coating; Powder metallurgy; Selection of materials - materials aspects, cost and manufacturing considerations;

Applications of materials to automobile and transport vehicles, aerospace, power generation, armament, marine environment and ocean structures, materials for other specialized applications; Assignment and mini-project.

Textbooks

1. Calister, W.D. *Material Science and Engineering - An Introduction* (John Wiley & sons, 1997)
2. Rajput, R.K. *Material Science and Engineering* (S. K. Kataria & Sons, 2008)

References

1. Gandhi, M.V. and Thompson, B.S. *Smart Materials and Structures* (Chapman and Hall, 1992)
2. Otsuka, K. and Wayman, C.M. *Shape Memory Materials* (Cambridge University Press, 1999)
3. Taylor, W. *Pizoelectricity* (Taylor & Francis, 1985)
4. Mallick, P.K. Fiber Reinforced Composites Materials, Manufacturing and Design (Marcel Dekker, 1993)

ME-592: Term Paper **L-T-P-CH-CR: 0-0-0-4-2**

This is a course of bit different flavor, aiming to help students to learn some research works beyond the normal curriculum. The main features of the course are:

(a) The course does not have any fixed syllabus, and hence no lecture, tutorial and practical.

(b) A student on consultation with a faculty member will survey literature on any research area of interest.

(c) The student will periodically present his/her observation to a board of faculty members.

(d) Finally the student will submit a report on his/her observation.

(e) An interested student will have the provision to carry out his/her MTech Thesis on the surveyed area.