

ADVANCES IN MECHANICAL ENGINEERING

Each Unit is of 2 credits. A candidate has to take any *three* units (6 credits)

UNIT 1: Convective Heat Transfer: Fully developed flows, exact and similarity solutions, boiling and condensation, special topics

Reference Books

- W.M Kays and M.E. Crawford, “Convective Heat and Mass Transfer”, McGraw Hill Intl.
- T Cebeci, “Convective Heat Transfer”, Springer

Unit 2: Mass Transfer: Mass transfer - 1, Droplet vaporization -1, Mass transfer-2, Droplet vaporization – 2, Mass transfer- 3 (Any two)

Reference Books

- W.M Kays and M.E. Crawford, “Convective Heat and Mass Transfer”, McGraw Hill Intl.
- D. Brian Spalding, “Combustion and mass Transfer”, 1st edition, Pergamon Press, 1979

Unit 3: Combustion: Premixed and Diffusion flames

Reference Books

- Kenneth K.Kuo, “ Principles of Combustion”, John Wiley and sons. Inc, 2005
- Irvin Glassman, “Combustion”, Academic Press, 1987
- Turns,S.R., “An Introduction to Combustion, Concepts and Applications”, Mc-Graw Hill, 2000
- Williams,F.A., “Combustion Theory” The Benjamin and Cummings Publishing Company Inc.,1985
- Law,C.K., “Combustion Physics”, Cambridge University Press,2006

Unit 4: Computational Fluid Dynamics – I (CFD – I): Finite volume algorithm, up-winding, Solution of pressure field on Cartesian meshes

Unit 5: Computational Fluid Dynamics – II (CFD-II) : Mesh generation

techniques, Solution on Non-Cartesian meshes.

Reference Books (*Common for both unit 4 and 5*)

- Wesseling P, “Principles of Computational fluid dynamics”, Springer
- Ferziger J.H., “Computational methods for fluid dynamics”, Springer
- Anderson, J.D. ”Computational Fluid Dynamics: The Basics with Applications”, McGraw Hill, 1995
- Ferziger, J.H. and Peric, M., “Computational Methods for Fluid Dynamics”, Springer, 1999
- Patankar, S.V., “Numerical Heat Transfer and Fluid Flow”, Narosa Publishing House, USA, 1980
- Date, A.W., “Introduction to Computational Fluid Dynamics”, Cambridge University Press, 2005
- Wilcox, D.C., “Turbulence Modelling for CFD”, DCW Industries Inc., 1994
- Chung, T.J., “Computational Fluid Dynamics”, Cambridge University Press, 2002
- Thompson, J.F., Warsi, Z.U.A. and C.W. Mastin, “Numerical Grid Generation-Foundations and Applications” North Holland, 1985

Unit 6: Turbulence: Governing equations, Free shear flows, Near wall behavior, Energy spectrum, Turbulence models

Reference Books

- Stephen B. Pope, “Turbulent flows”, Cambridge Univ. Press
- Hinze J.O., “Turbulence”, McGraw Hill

Unit 7: Vibrations: Multi-degree freedom systems, Approximate and numerical methods, Continuous systems, Nonlinear systems

Reference Books

- Balakumar Balachandran and Edward Magrab, “Vibrations”, Thomson Brooks/Cole, 2004.
- Kelly S.G., “Mechanical vibrations”, McGraw-Hill, 2007

Unit 8: Acoustics: Wave propagation, generation/transmission of sound, noise control

Reference Books

- Kinsler, Frey and Coppens, “Fundamentals of Acoustics”, John Wiley & Sons
- Allan D Pierce, “Acoustics: An Introduction to its Physical Principles and Applications”, Acoustical Society of Amer, 1989.

Unit 9: Fracture Mechanics: Linear Elastic Fracture Mechanics, Elastic Plastic Fracture Mechanics, Fracture Mechanisms in Metals

Reference Books

- T L Anderson, Fracture Mechanics- Fundamentals and Applications, CRC Publishers, 2nd edition, 1995
- Ashok Saxena, Nonlinear Fracture Mechanics for Engineers, CRC Publications
- Hertzberg R.W., Deformation and Fracture Mechanics of Engineering Materials, Wiley, 4th edition, 1996.

**Unit 10: Advanced Topics in Refrigeration and Cryogenics
Refrigeration applications in preservation of Food, transport by trucks and containers; Railway cars; Marine Refrigeration; Fans and Blowers, Sound Control.
Construction of psychrometric charts, enthalpy deviation curves (Any two)**

Reference Books

- ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration
- Threlkeld J.L., “Thermal Environmental Engineering”, Prentice Hall
- Dossat R.J., Principles of Refrigeration, Pearson Education Asia
- Handbook of air-conditioning system design, Carrier Incorporation, McGraw Hill Book Co., U.S.A.
- Hainer R.W. ‘Control Systems for Heating, Ventilation and Air – Conditioning’, Van Nastrand Reinhold Co., New York, 1984.

**Unit 11: Advanced Theory of Elasticity (3-dimensional problems):
Theories of Stress and strain, Transformation of stress and strain, Linear stress-strain – temperature relations,
Applications of energy methods, Torsion, Bending, Plates**

Reference Books

- Boresi A.D., Schmidt R.J, and Sidebottom O.M, “Advanced Mechanics of Materials”, Wiley
- Richard Budynas, “Advanced strength of applied stress analysis”, McGraw Hill
- Cook R.D., Young W.C., “Advanced Mechanics of Materials”, Prentice Hall
- Timoshenko and Goodier, “Theory of Elasticity”, McGraw-Hill Publications
- Ugural and Fenster, “Advanced Strength and Applied Elasticity”, 4th Ed., Prentice Hall, PTR, 2003.
- Srinath L.S, “Advanced Mechanics of Solids”, Tata Mc-Graw Hill, New Delhi, 2003.

Unit 12: Advanced gas dynamics: Linearized flow, Method of characteristics, Shock boundary layer interaction, Numerical methods

Reference Books

- Anderson J.A., “Compressible Flow”, McGraw Hill.
- Shapiro A.H., “Dynamics and Thermodynamics of Compressible Fluid Flow”, MIT Press
- Zucker R. D. and Biblarz Oscar, “Introduction to Gas Dynamics”, John Wiley and Sons. Inc., Second Edition, 2002

Unit 13: Robotics: Kinematics, Dynamics, Trajectory, Control

Reference Books

- John J Craig, “Introduction to Robotics – Mechanics and Control”, Prentice Hall, 3rd Edition, 2004.
- Fu K.S., Gonzales R.C., and Lee C.S.G., “Robotics: Control, Sensing, Vision and Intelligence, Tata Mc-Graw Hill, 2008.

Unit 14: Advanced Topics in I C Engines: Engine Emissions & Control, Engine Electronics, Modelling Real Engine Flow and Combustion Process, Fuel/Air Mixture Requirements (Any two)

Reference Books

- Charles Fayette Taylor, “The Internal Combustion Engine in Theory and Practice”, Vol. I & II, The MIT Press.

- John B Heywood, “Internal Combustion Engine Fundamentals”, McGraw Hill International Edition, 1998.
- Makartchouk, A., “Diesel Engine Engineering: Thermodynamics, Dynamics, Design, and Control”. New York, and Basel: Marcel Dekker, Inc., 2002.
- SAE publications
- Blair, G., “The Basic Design of Two-Stroke Engines”, Warrendale, PA: Society of Automotive Engineers, 1990.
- Owen, K., and Coley.T., “Automotive Fuels Handbook”. Warrendale, PA: Society of Automotive Engineers, 1990.

Unit 15: Finite Element Methods

Thermal analysis (temperature effects), 2D, 3D elements, Contact analysis, Non-linear static analysis

Reference Books

- Bathe K J “Finite Element Procedures”, Cambridge, MA 2007
- Sequerlind L J, “Finite Element Analysis”, Wiley, 2nd edition, 1984
- Reddy J.N., “An Introduction to Finite Element Method”, McGraw Hill

Unit 16: Micro Electro Mechanical Systems (MEMS):

From Microphysics to Macrophysics, Thermodynamics of Microstructures, Reliability of MEMS

Reference Books

- Balian Roger, “From Microphysics to Macrophysics”, 1st edition, Springer, 2006.
- Thermodynamics of Microstructures, ASM International, 2008
- Younes Shabany, “Heat transfer Thermal Management of electronics”, CRC Press.
- Electronics cooling magazine issues from 1997 -2010

Unit 17: Bio-medical device design

Applications, FDA approval procedures, A Certification

Reference Books

- Shiegly J.E., Machine design
- Richard Fries and Paul King www.crcpress.com
- Anatomy by Gray 1918
- Pathology by Simpson
- Principles of Orthopedic deformity correction - by Dror Paley www.springer.com

- FDA procedures – Class notes

**Unit 18: Systems design for Cooling of Electronic Equipments
Enclosure design, power packing factors, electronic packing**

Reference Books

- Faghri Amir, “Heat Pipe Science and Technology”, Taylor & Francis, 1995.
- Dunn and Reay, “Heat Pipes”, Pergamon, 4th Edition,
- Kaveh Azar, “Thermal Measurements in Electronic Cooling”, CRC Press, 1997.

Unit 19: Reliability Engineering: Reliability evaluation of complex systems, Safeties and certifications, Terro technological Aspects

Reference Books

- 1) M/c standard 8005
- 2) Kapur K.C., and Lamberson L.R., “Reliability in Engineering Design”, Wiley India Pvt. Ltd., 2009.

Unit 20: Turbo Machinery: Analysis of flow, Design aspects, Cooling of turbo-machines, Special topics (Thermal and Hydro turbo machines)

Reference Books

- Lakshminarayana B., “Fluid Dynamics and Heat Transfer of Turbo Machinery”, Wiley – Interscience, 1995.
- Rangwala A.S., “Turbo-Machinery Dynamics”, McGraw Hill,
- Earl Logan, Jr, Ramendra Roy, “Handbook of Turbo Machinery”, 2nd Edition (Mechanical Engineering, No. 158)
- Rama S.R. Gorla, “Turbo Machinery: Design and Theory”, Marcell Dekker
- Duncan Walker, “Torsional Vibration of Turbo-Machinery”,
- R. I. Lewis, “Turbo machinery Performance Analysis”

Unit 21: Metal Forming: Yield criteria, Slip line field theory, Temperature Field in Material.- Plastic and Visco-plastic behaviour of material, Surfaces of Discontinuity, Numerical Models of Plasticity.

Reference Books

- Sluzalec and Andrzej, “Theory of Metal Forming Plasticity - Classical and Advanced Topics” Springer Publications
- Avitzur B., “Metal Forming - Process and analysis” Tata Mc-Graw Hill
- Mielnik E.M., “Metal working science and Engineering”, Mc-Graw Hill. Inc

Unit 22: Metal Machining - Modelling and control of Chip Formation, Machining of hard materials and metal matrix reinforced composites, Characterization and surface integrity in hard machining, Modern concepts of machining

Reference Books

- Milton C Shaw, “Metal Cutting Principles” 2nd Edition, Oxford series in Advanced Manufacturing.
- Paulo Davim (Ed.), “Machining – Fundamentals and Advances” Springer-Verlag, London, 2008.
- Childs Thomas, Maekawa K., Obikawa T., and Yamane Y., “Metal machining – Theory and Applications” John Wiley & Sons, New York, 2000

Unit 23: Modelling of Manufacturing Systems: Markov chains – Continuous and Discrete, Petri nets – Timed and Stochastic

Reference Books

- Viswanadham, N and Narahari, Y. “Performance Modelling of Automated Manufacturing Systems”, Prentice Hall of India, New Delhi, 2000
- Hruz B. and Zhou M.C., “Modelling and Control of Discrete Event Dynamic Systems”, Springer, London, 2007.
- Curry G., Feldman R.M., “Manufacturing Systems Modelling and Analysis”, Springer-Verlag, Heidelberg, 2009.

Unit 24: Reverse Engineering : Reverse engineering - Methodologies and Techniques, Hardware and software, Rapid prototyping – Relationship with reverse engineering

Reference Books

- Vinesh Raja and Kiran J Fernandes, “Reverse Engineering – An Industrial perspective”, Springer, London, 2008

- Pham D and Dimov S, “Rapid manufacturing - The technologies and applications of rapid prototyping and rapid tooling. Springer-Verlag, London, 2001.

Unit 25: Advanced Machining Processes: Hybrid electro-chemical processes, Hybrid thermal processes, Solid, liquid and powder based material addition processes (Analytical Study)

Reference Books

- Hassan El-Hofy, “Advanced Machining Processes – Non Traditional and Hybrid Machining Processes”, Mc-Graw Hill, London, 2005
- Brown J., “Advanced Machining Technology Handbook”, Mc-Graw Hill, New York, 1998

Unit 26: Manufacturing Systems: Machine tool design, control, automation and analysis, Computerized process planning

Reference Books

- George Chryssolouris, “Manufacturing Systems: Theory and Practice”, 2nd Edition, Springer, New York, 2006.
- Chang T.C., “Expert Process Planning for Manufacturing”, Addison – Wesley, MA, 1990
- Slocum A.H., “Precision Machine Design”, SME, Prentice-Hall Inc, 1992.

Unit 27: High Integrity Die Casting: Vacuum die casting, Squeeze casting, Semi solid metal working, Design considerations for high integrity die Castings

Reference Books

- Edward J Vinarcik, “High Integrity Die Casting Processes”, John Wiley & Sons Inc., New York, 2003.
- Campbell John, “Castings”, Butterworth – Heinemann, 2000.

Unit 28: Computational Welding Mechanics: Models for welding heat sources, Thermal analysis of welds, Fracture Mechanics of welded structures

Reference Books

- Goldak J.A., and Akhlaghi M., “Computational Welding Mechanics”, Springer, New York, 2005.
- Radaj D., “Heat Effects on Welding: Temperature field. Residual stress and Distortion”, Springer, 1992.

Unit 29: Composite Materials: Elastic behavior of unidirectional and multi directional composites, Laminated composite beams and plates (Any one)

Reference Books

- Isaac and Daniel M., “Engineering Mechanics of Composite Materials”, Oxford University Press, 1994.
- Jones R.M., “Mechanics of Composite Materials”, McGraw Hill, New York, 1975
- Calcote L.R., “Analysis of Laminated Composite Structures”, Van Nostrand Rainfold, New York, 1969