DEPARTMENT OF AERONAUTICAL & AUTOMOBILE ENGINEERING

MTECH: APPLIED COMPUTATIONAL FLUID DYNAMICS

Program Structure (Applicable to 2023 admission onwards)

YEAR	FIRST SEMESTER						SECOND SEMESTER					
	SUB CODE	SUBJECT NAME	L	T	P	C	SUB CODE	SUBJECT NAME	L	T	P	C
I	MAT 5123	Advanced Engineering Mathematics	3	1	0	4	AAE 5218	Turbulence Modelling and Simulation	3	1	0	4
	AAE 5122	Numerical Methods for Partial Differential Equations (PDEs)	3	1	0	4	AAE 5219	Introduction to Finite Element Analysis of Solids and Fluids	3	1	0	4
	AAE 5123	Fundamentals of Fluid Dynamics and Heat Transfer	3	1	0	4	AAE ****	Program Elective-I	3	1	0	4
	AAE 5124	Introduction to the Numerical Solution of the Navier-Stokes equations	3	1	0	4	AAE ****	Program Elective-II	3	1	0	4
	AAE 5125	Computational Aerodynamics	3	1	0	4	AAE ****	Program Elective-III	3	1	0	4
	HUM 5051	Research Methodology and Technical Communication*	1	0	3	-	*** ****	Open Elective	3	0	0	3
	AAE 5146	CFD Lab-1	0	0	6	2	HUM 5051	Research Methodology and Technical Communication*	1	0	3	2
	AAE 5147	Modeling & Design Lab	0	0	3	1	AAE 5245	CFD Lab-2	0	0	3	1
							AAE 5246	Aerodynamics Lab	0	0	3	1
	Total					**23**						**27**
	THIRD AND FOURTH SEMESTER											
II	AAE 6091	Project Work and Industrial Training							**0**	**0**	**0**	**25**

*TAUGHT IN BOTH SEMESTERS AND EVALUATED AND CREDITED IN THE SECOND SEMESTER

**LAB COURSES 2 & 3 AND 4&5 MAY BE COMBINED INTO ONE BY EITHER ALLOTTING 6 Hrs/WEEK OR 3 Hrs/WEEK WITH A PROVISION FOR MINI PROJECT/ASSIGMENTS

PROGRAM ELECTIVES		OPEN ELECTIVES	
OURSE CODE	COURSE TITLE	OURSE CODE	COURSE TITLE
AAE 5401	Biofluid Dynamics	AAE 5301	Design and Analysis of Thermal Systems
AAE 5402	Chemically Reacting Flows	AAE 5302	Aerodynamics of Rockets and Missiles
AAE 5403	Combustion and emission	AAE 5303	Aircraft Propulsion
AAE 5404	Environmental Flows		
AAE 5405	Fluid Structure Interaction		
AAE 5406	Linking Experiments with CFD		
AAE 5407	Modeling and Simulation of Energy Systems		
AAE 5408	Multiphase flows		
AAE 5409	Numerical Simulation of Atmospheric Flows		
AAE 5410	Transport Phenomena		
AAE 5411	Vehicle Aerodynamics		

MTech in Applied Computational Fluid Dynamics

FIRST SEMESTER

MAT 5123: ADVANCED ENGINEERING MATHEMATICS [3 1 0 4]

Mathematical Modelling with ordinary/partial/higher-order differential equations: Models in arms race, compartment models, heat flow problems and vibration of strings. Modelling through graphs. Solution of the linear and non-linear system of equations: Direct methods, Thomas Algorithm for tridiagonal systems and Indirect Methods(Iterative methods). Eigenvalues & Eigenvectors using Power Method. Newton Raphson method (system of non-linear equations), Birgevieta method, Bairstow's methods. Numerical Solution of Ordinary Differential Equations: Initial Value Problems: Single-step methods, Runge Kutta method, RungeKutta method for simultaneous differential equations, Runge Kutta method for higher-order differential equations, Shooting method. Application to engineering problems. Multi-step methods: Adam Bashforth's predictor-corrector method, Milne's predictor and corrector method. Boundary Value Problems: Finite difference method, numerical Solution of Partial Differential Equations, finite difference method for elliptic, parabolic and hyperbolic equations.

References:

1. Atkinson K.E: An Introduction to Numerical Analysis, edn 3, John Wiley and Sons (1989).
2. G. D. Smith, Numerical Solution of Partial Differential Equations, Oxford University Press.
3. Jain, Iyengar and Jain: Numerical Methods for Scientific and Engineering Computations, New Age Publishers.
4. J. N.Kapoor, Mathematical Modeling, 1988 Wiley Eastern
5. R.Aris, Mathematical Modeling Techniques, 1978 Pitman.

AAE 5122: NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS (PDEs) [3 1 0 4]

Classification of Partial Differential Equations, The Finite Difference Method, Iterative Methods for Linear Systems – Elliptic equations, Parabolic Partial Differential Equations, Hyperbolic Partial Differential Equations, General Partial Differential Equations, The Finite Volume Method, The Finite Element Method, Mesh generation.

References:

1. J. D. Hoffman, Numerical Methods for Engineers and Scientists, McGraw-Hill, Inc. New York, 1992.
2. K. W. Morton and D. F. Mayers, Numerical Solution of Partial Differential Equations, Cambridge, 2nd Edition
3. Ferziger, J. H.; Perić, M.: Computational Methods for Fluid Dynamics. Berlin etc., Springer-Verlag, 1996.
4. J. N. Reddy, An Introduction to the Finite Element Method, 3rd edition, 2006.
5. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, PHI Learning Private Limited, 2011

AAE 5123: FUNDAMENTALS OF FLUID DYNAMICS AND HEAT TRANSFER [3 1 0 4]

Fluid Properties and Fluid Statics, Fluid Kinematics-Velocity and acceleration description, Continuity equation in 3D flow, stream function, velocity potential function. Potential flow (uniform, source, sink and combination) and its description. Characteristics of the boundary layer along a thin flat plate, Exact Solutions of Navier Stokes Equations. Derivation of momentum Equation-Numerical problems. Derivation of Energy Equation-Numerical problems

Thermodynamic relations, Use of the first law to understand its application for open systems such as turbine, nozzle and heat exchanger. The second law of thermodynamics. The fundamental concepts of heat transfer, conduction, convection and radiation. Transient heat conduction, internal & external forced convections. Various power cycles and comparison of the otto, diesel, and dual cycle performance.

References:

1. G K Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press.
2. Edward J Shaughnessy, Jr., Ira M Katz, Introduction to Fluid Mechanics, Oxford University press
3. Ozisik, M. N., Heat Transfer – A Basic Approach, McGraw- Hill
4. McCabe, W. L., Smith, J.C. and Harriott, P., ‘Unit Operations of Chemical Engineering ’, McGraw- Hill,
5. Heat Transfer: A Practical Approach, McGraw-Hill,

AAE 5124: INTRODUCTION TO THE NUMERICAL SOLUTION OF THE NAVIER-STOKES EQUATIONS [3 1 0 4]

Introduction, How to check our numerical solution codes, Hands-on session 1 (Computer lab.), Starting our code, Hands-on session 2 (Computer lab.), Discretization of diffusive and convective terms, Hands-on session 3 (Computer lab.), Presentation of results - P1, Time marching algorithm and the incompressibility constraint, Pressure-velocity coupling and the Poisson equation, Hands-on session 4 (Computer lab.), Hands-on session 5 (Computer lab.), Boundary conditions, Hands-on session 6 (Computer lab.), Presentation of the results – P2.

References:

1. Anderson, J. “Computational Fluid Dynamics”, McGraw-HilL
2. Versteeg, H. “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Pearson

AAE 5125: COMPUTATIONAL AERODYNAMICS [3 1 0 4]

Fundamental of aerodynamics, Introduction to CFD, Simulation of inviscid flows, Simulation of viscous flows and introduction to turbulence modelling, Aerodynamics case studies,

References:

1. Applied computational aerodynamics: a modern engineering approach, Russell M. Cummings, William H. Mason, Scott A. Morton, and David R. McDaniel, 2015 by Cambridge University Press

HUM 5101: RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of research methodology: basic concepts: types of research, significance of research, research framework case study method, experimental method, sources of data, data collection using a questionnaire, interviewing, and experimentation. Research formulation: components, selection and formulation of a research problem, objectives of formulation, and criteria of a good research problem. Research hypothesis: criterion for hypothesis construction, nature of hypothesis, need for having a working hypothesis, characteristics and types of hypothesis, the procedure for hypothesis testing; sampling methods: introduction to various sampling methods and their applications. Data analysis: sources of data, collection of data, measurement and scaling technique, and different techniques of data analysis. Thesis writing and journal publication: writing thesis, writing journal and conference papers, IEEE and Harvard styles of referencing, effective presentation, copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, "Research Methodology; A Step-by-Step Guide for Beginners", SAGE. 2005.
2. Geoffrey R. Marczyk, David De Matteo & David Festinger, "Essentials of Research Design and Methodology", John Wiley & Sons, 2004.
3. John W. Creswel, "Research Design: Qualitative, Quantitative, and Mixed Methods approaches", SAGE. 2004.
4. Suresh C. Sinha and Anil K. Dhiman, "Research Methodology (2Vols-Set)", Vedam Books., 2006.
5. C. R. Kothari, "Research Methodology; Methods & Techniques", new age international publishers, New Delhi., 2008.

AAE 5146: CFD LAB 1 [0 0 6 2]

Introduction to CFD and ANSYS Workbench (CFX/FLUENT), Overview of Meshing Techniques for 2D flow problems, Application of CFD for incompressible flows-Jet dynamics, Flow over an airfoil, Flow over a cylinder, A 3D bifurcating Artery, Advanced aspects of post-processing

References:

1. Ansys Fluent 2020 R1-Theory Guide
2. Versteeg, Henk Kaarle, and Weeratunge Malalasekera. An introduction to computational fluid dynamics: the finite volume method. Pearson Education, 2007.
3. John Matsson, An Introduction to ANSYS Fluent 2020, SDC Publications, 2020
4. Suhas Patankar, Numerical heat transfer and fluid flow, CRC Press
5. Blazek, Jiri. Computational fluid dynamics: principles and applications. Butterworth-Heinemann, 2015.

6. John D. Anderson, Jr, Computational Fluid Dynamics: The Basics with Applications
7. Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, Computational Fluid Dynamics: A Practical Approach, Butterworth-Heinemann 2007

AAE 5147: MODELING & DESIGN LAB [0 0 3 1]

Basics of CATIA & Creo PRO-E, modeling techniques, two dimensional modeling, three dimensional modeliling, modeling of automotive subsystems, engine, piston, crankshaft, disc, drum brake, tyre, surfacing, modeling of car using views, assembly of components. Basic introduction to MATLAB, design of dump truck, analysis of automobile shock absorber, engine model simulation, vehicle dynamics, cruise control simulation

References

1. Michael Michaud, CATIA Core Tools: Computer Aided three dimensional interactive applications, McGraw Hill Professional Publication 2012
2. Prof Sham Tickoo, CATIA V5R17 for engineers & Designers, Dreamtech Press Publication, 2012
3. Nadar G Zamani, Jnonathan M Weaver, Catia V5 tutorials mechanisms, Design & Animation release 21, SDC Publication, 2012
4. Kuang-Hua Chang, Mechanism Design with Creo Elements/Pro 5.0: (Pro/ENGINEER Wildfire 5.0), SDC Publication, 2011.
5. MATLAB 6 for EngineersL Hands-on Tutorial, Joe King, Library of Congress Publication, 2001
6. Rao V Dukkipati, MATLAB for Mechanical Engineers, New age Science Publication, 2009.

SECOND SEMESTER

AAE 5218: TURBULENCE MODELLING AND SIMULATION [3 0 1 4]

Introduction, Turbulent flow statistics. Turbulent flow statistics. Practical session (Computer lab.), Turbulent mean flow , Turbulent mean flow. Practical session (Computer lab.), Transport equations for kinetic energy and Reynolds stresses, Transport equations for kinetic energy and Reynolds stresses. Practical session (Computer lab.),Presentation of results of assignment 1 & 2 - P1,,Turbulence modelling and simulation. Introduction, Assessing mesh resolution. Practical session (Computer lab.), Turbulence modelling. Large-eddy simulation, Large-eddy simulations. Practical session (Computer lab.), Turbulence modelling. Reynolds-Averaged Navier-Stokes (RANS) models, RANS models. Practical session (Computer lab.), Presentation of the results of assignment 3– P2

References:

1. Bradshaw, P. (1971) An introduction to turbulence and its measurements. Pergamon Press
2. Tennekes, H. and Lumley, J. L. (1972) 'A first course in turbulence'. MIT Press.
3. Pope, S. B. (2001) Turbulent Flows. Cambridge University Press

AAE 5219: INTRODUCTION TO FINITE ELEMENT ANALYSIS OF SOLIDS AND FLUIDS [3 1 0 4]

Introduction to Finite Element Method, Two dimensional FEM and higher-order element, Application to Solid Mechanics: one-dimensional Beam, Application to Solid Mechanics: Multi-dimensional problems, Application to Fluid Mechanics, Analysis of Finite element method and parallel solution procedure

References:

1. Fundamentals of the Finite Element Method for Heat and Fluid Flow, Roland W. Lewis Perumal Nithiarasu Kankanhalli N. Seetharamu,2004 by John Wiley & Sons.
2. The Finite Element Method for Fluid Dynamics, Zienkiewicz, Taylor, Nithiarasu, 7th ed., 2013, by Butterworth-Heinemann
3. MATLAB Codes for Finite Element Analysis, A. J. M. Ferreira and N. Fantuzzi, 2nd ed., 2009 by Springer

AAE 5245: CFD LAB 2 [0 0 3 1]

Advanced aspects of CAD modelling and surface meshing, Guidelines on-grid generation-complex 3D flow problems, Introduction to OpenFoam, Application of CFD for incompressible flows-Jet dynamics, Application of CFD for compressible flows-Aerodynamics, Application of CFD for Multiphase flow analysis, Application of CFD for Fluid-Structure Interaction (FSI) analysis, Advanced aspects of post-processing.

References:

1. Edelsbrunner, Herbert. Geometry and topology for mesh generation. Cambridge University Press, 2001.
2. Sadrehaghighi, Ideen. "Mesh generation in CFD." CFD Open Ser 151 (2017)
3. Tu, Jiyuan, Guan Heng Yeoh, and Chaoqun Liu. Computational fluid dynamics: a practical approach. Butterworth-Heinemann, 2018
4. Blazek, Jiri. Computational fluid dynamics: principles and applications. Butterworth-Heinemann, 2015.
5. Moukalled, Fadl, L. Mangani, and Marwan Darwish. The finite volume method in computational fluid dynamics-. An Advanced Introduction with OpenFOAM® and Matlab® Vol. 113. Berlin, Germany: Springer, 2016
6. Bazilevs, Yuri, Kenji Takizawa, and Tayfun E. Tezduyar. Computational fluid-structure interaction: methods and applications. John Wiley & Sons, 2013.
7. Ansys Fluent 2020 R1-Theory Guide

AAE 5246: AERODYNAMICS LAB [0 0 3 1]

Introduction to wind tunnel, its specifications and calibration, Pressure distribution and pressure drag calculation over a cylinder, Pressure distribution and calculation of lift over a symmetric airfoil, Pressure distribution and calculation of lift over a cambered airfoil, Calculation of Zero Lift Angle on a Cambered Airfoil, Hot Wire Anemometer, Calculation of Drag of Cylinder with the use of Wake Survey Method, Calculation of Drag of airfoil by use of Wake Survey Method, Demonstration of 6 component balance and water tunnel visualization, Axial flow fan performance, Performance of convergent nozzle, Performance of mini gas turbine, Bomb calorimeter, propeller test rig experiment, Calculation of burning velocity, forced & natural convection

References:

1. Low speed wind tunnel testing, Jewel B Barlow, William H Rae, Alan Pope
2. Fundamentals of Aerodynamics, J.D. Anderson
3. Lab Manuals of Aerodynamics & Propulsion Lab
4. Houghton E. L. and Carruthers N. B., Aerodynamics for Engineering Students, Edward Arnold Publishers Ltd., London, 1989.

PROGRAM ELECTIVES

AAE 5401: BIOFLUID DYNAMICS [3 1 0 4]

Elements of Continuum Mechanics. Biofluid Dynamics Concepts. Analyses of Arterial Diseases. Biofluid Mechanics of Organ Systems. Case Studies in Biofluid Dynamics, urodynamics, respiratory flow

References:

1. Clement Kleinstreuer, Biofluid Dynamics Principles and Selected Applications, CRC Press, Taylor & Francis
2. David A Rubenstien, Wei Yin, Mary D Frame, Biofluid Mechanics-an introduction to fluid mechanics, macro circulation and micro circulation, Elsevier Science
3. Megh R Goyal, Biofluid Dynamics of Human Body Systems, CRC Press, Taylor & Francis

AAE 5402: CHEMICALLY REACTING FLOWS [3 1 0 4]

Introduction to combustion flow physics, Reacting flow numerical modelling methods, Application of reacting flow for gas turbine combustors, Introduction to spray modelling, Spray modelling application, Combustion simulation with liquid fuel atomisation.

References:

1. Ansys Fluent 2020 R1-Theory Guide
2. Gas turbine combustion, Lefebvre, CPC Press
3. Theoretical and Numerical Combustion, Poinsot and Veynante
4. Atomisation and Spray, Lefebvre, Taylor & Francis
5. Comprehensive Gas Turbine Combustion Modeling Methodology, Mongia, 2007

AAE 5403: COMBUSTION AND EMISSION [3 1 0 4]

Introduction to combustion, principles and applications of combustion, characterization of fuels, laws of thermodynamics, fundamental laws of transport, basic reaction kinetics, global kinetics, regulatory test proceedures, analysis of pollutants, pollution diagnosis and instrumentation, NDIR analyzers, thermal conductivity and flame ionization detectors, EGR, catalytic converter, thermal reactors, fuel modifications

References:

1. Colin R Ferguson, Allan T. Kirkpatrick, Internal Combustion Engines-Applied Thermosciences, John Wiley and Sons Inc. U.K. 2015.
2. Willard W Pulkrabek, Engineering Fundamentals of internal combustion Engine, Pearson Education Inc, USA (1e) 2004.

3. J. B. Heywood, Internal combustion Engine, Tata McGraw Hill Pvt Ltd, India, 1989
4. M. L. Mathur, R. P. Sharma, Internal Combustion Engine, Dhanpat Rai Publications, India (2e) 1994

AAE 5404: ENVIRONMENTAL FLOWS [3 1 0 4]

Introduction, Modelling techniques, Buildings and urban environment, Simulation of airflow in the urban environment, Atmospheric dispersion modelling, Simulation of pollutant dispersion, Environmental hydraulics and transport processes, Pollutant transport in a channel flow, Soil erosion, Erosion in bare soil area.

References:

1. Environmental modelling: finding simplicity in complexity / [edited by] John Wainwright and Mark Mulligan. – 2nd ed., 2013 by John Wiley & Sons
2. Handbook of Environmental Fluid Dynamics, / [edited by] H. J. S. Fernando, 2013 CRC Press by Taylor & Francis Group
3. Computational fluid dynamics: applications in environmental hydraulics/ editors, Paul D. Bates, Stuart N. Lane, Robert I. Ferguson, 2005 John Wiley & Son.

AAE 5405: FLUID STRUCTURE INTERACTION [3 1 0 4]

Introduction, Governing Equations of Fluid and Structural Mechanics (Theory), Basics of Finite Element Method for Non-moving domains problems, ALE and time space-time methods for moving boundaries and Inter-faces, ALE and time space-time methods for FSI, Engineering applications of FSI, Biomedical Applications of FSI, Aerodynamics FSI, Vibroacoustics FSI

References:

1. Païdoussis, M. P., Price, S. J., & de Langre, E. (2011). Fluid-structure interactions: Cross-flow-induced instabilities Cambridge University Press.
2. Yuri Bazilevs, Kenji Takizawa, Tayfun E Tezduyar, Computational Fluid-Structure Interaction-methods and applications, (2013) Wiley Series
3. Abdelkhalak El Hami, Bouchaib Radi, Fluid-structure Interactions and Uncertainties, volume 6, 2017, Wiley Publications
4. Yong Zhao, Xiaohui Su, Computational Fluid-Structure Interaction-methods, models and applications, (2019), Academic Press

AAE 5406: LINKING EXPERIMENTS WITH CFD [3 1 0 4]

Introduction to notion of validation Data types and key validation methods, Principles of CFD validation in space/time, ASME/AIAA/SAE validation procedures (simplify standards of verification and validation in CFD), The AGARD-CFD validation procedure for aerospace CFD predictions, Lab experiment linked with numerical simulation, Demo test cases.

References:

1. Roache, P. J. (1998). Verification and Validation in Computational Science and Engineering, Hermosa Publishers, Albuquerque, NM
2. TU, J., YEOH, G. H., & LIU, C. (2018). Computational fluid dynamics a practical approach.

AAE 5407: MODELING AND SIMULATION OF ENERGY SYSTEMS [3 1 0 4]

Introduction-, Thermal power plant, Hydropower plant, Wind power plant, Propulsion plant, Heating: Solar collector, Cooling: Condenser

References:

1. Thomas A. Adams II(2019),Modeling and Simulation of Energy Systems, MDPI.

AAE 5408: MULTIPHASE FLOWS [3 1 0 4]

Introduction, Liquid-Gas Two-Phase Flows (Theory), Liquid-Gas Two-Phase Flows (Project), Particle Motion, Bubble/Droplets Formation and Cavitation, Euler-Lagrangian Model, Volume-of-Fluids Model, Euler-Euler Model

References:

1. Brennen, C. (2005). Fundamentals of Multiphase Flow. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511807169
2. Guan Heng Yeoh, Jiyuan Tu. (2019). Computational Techniques for Multiphase Flows (Second Edition). Butterworth-Heinemann. ISBN 9780081024539. https://doi.org/10.1016/B978-0-08-102453-9.12001-X.

AAE 5409: NUMERICAL SIMULATION OF ATMOSPHERIC FLOW [3 1 0 4]

Fundamentals of Atmospheric Processes, Thermodynamics and Boundary Layer Processes, The SW model theory and numerical methods, SW model implementation

References:

1. Fundamentals of Atmospheric Modelling Mark Jacobson. 2nd Edition (2005). Publisher: ISBN-10: 0521548659 ISBN-13: 978-0521548656. Cambridge University Press. U.K
2. Computational Methods in Environmental Fluid Mechanics. Kolditz Olaf. 1st Edition (2002). ISBN 978-3-540-42895-4. Springer
3. Atmosphere, Ocean and Climate Dynamics. John Marshall and Alan Plumb. 1st Edition (2007). ISBN-10: 0125586914 | ISBN-13: 978-0125586917 | Elsevier Academic Press. USA
4. Pedlosky, "Geophysical Fluid Dynamics", Springer
5. Benoit Cushman-Roisin & Jean-Marie Beckers, "Introduction to Geophysical Fluid Dynamics, Physical and Numerical Aspects", Academic Press
6. 3.Jochen Kämpf, "Ocean Modelling for Beginners". Springer.
7. 4.Versteeg, H. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson

AAE 5410: TRANSPORT PHENOMENA [3 1 0 4]

Momentum Transport- Introduction to molecular momentum transport; Newtonian vs non-Newtonian fluid viscosity models; Shell balances; Equation of change for isothermal systems; Momentum transport problem with 2 independent variables,
Energy Transpor- Introduction of mechanism of energy transport; Shell balances on energy transport for 1D problem; Equation of change for nonisothermal system; Energy transport problem with 2 independent variables,
Species (Mass) Transport- Diffusivity and mechanism of mass transport; Shell balances on mass transport for 1D problem; Equation of change for multicomponent systems; Mass transport problem with 2 independent variables

References:

1. "Transport Phenomena" by Bird, R.B., Stewart, W.E. and Lightfoot, E.N
2. "Fundamentals of Momentum, Heat and Mass Transfer" by Welty, Wicks, Wilson and Rorrer
3. ANSYS FLUENT and/or COMSOL User's Guide
4. ANSYS FLUENT and/or COMSOL Theory Guide

AAE 5411: VEHICLE AERODYNAMICS [3 1 0 4]

Introduction, Historical development, Fundamentals of fluid mechanics, properties of incompressible fluid, basic equations of incompressible flow, friction drag and pressure drag, aerodynamic drag of passenger cars, aerodynamics of commercial vehicles, tractive effort and fuel consumption, reducing aerodynamic drag in trucks, aerodynamics of high performance vehicles, aerodynamic features of race cars, vehicle dynamics under side wind, influence of vehicle shape on aerodynamic forces and moments, Experimental procedure and facilities, types of wind tunnels, Instrumentation for wind tunnels, pressure measurement, velocity measurement, force and moment measurement devices, flow visualization

References:

1. Hucho W. H, Aerodynamic of Road Vehicles, Butterworths Co. Ltd, 1997
2. Wolf-Heinrich Hucho, Aerodynamics of Road Vehicles: From Fluid Mechanics to Vehicle Engineering, 1990.
3. Pope. A, Wind Tunnel Testing, John Wiley & Sons, (2e) Newyork, 1974
4. Handbook on vehicle body design, SAE Publications, 1993
5. Rose Mc Callen, Fred Browand, The Aerodynamics of Heavy Vehicles: Trucks, Buses and Trains, Volume 1, 2004.

OPEN ELECTIVES

AAE 5301: DESIGN AND ANALYSIS OF THERMAL SYSTEMS [2 1 0 3]

Introduction, basics of thermodynamics, modes of heat transfer, engineering design, modeling of thermal systems, mathematical and physical modeling, basic heat exchanger design, materials for thermal application, super conductive materials, nanomaterials, optimization in design, programming, economic factors in design

References:

1. Adrian Bejan, George Tsatsaronis, Michael Moran, Thermal Design and Optimization, John Wiley & Sons, 1996
2. Robert F. Boehm, Developments in Design of Thermal Systems, Cambridge University Press, 1997
3. W. F. Stoeker, Design of thermal systems, Tata Mcgraw-hill 2011
4. R. F. Boehm, Design analysis of thermal systems, Wiley, 1987
5. Yogesh Jaluria, Design and Optimization of thermal systems, CRC press, Taylor & Francis, 2007.

AAE 5302: AERODYNAMICS OF ROCKETS AND MISSILES [2 1 0 3]

Airframe components of rockets and missiles- Forces acting on a missile while passing through the atmosphere- Classification of missiles- Types of design and control. Kinematics of flow, Mach and shock waves, Theory of fluid flow about slender bodies. Method of describing aerodynamic forces and moments-Lateral aerodynamic moment-Lateral damping moment and longitudinal moment of a rocket-Lift and drag forces-Drag estimation - Body upwash and downwash in the missiles Rocket dispersion. The non-linear potential equation, linearization of potential equation, Bernoulli's equation, line pressure source, aerodynamic characteristics of rectangular and triangular lift surfaces on the basis of supersonic wing theory, simple sweep theory, conformal mapping. Aerodynamic code requirements and uses in various missile design stages, types of aeroprediction codes, conventional approximate aerodynamic methods, new approximate aerodynamic methods.

References:

1. Jack N Nielsen, Missile Aerodynamics, Mc Graw Hill Publication, 1960.
2. Richard Dow, Fundamentals of Advanced Missiles, John Wiley and sons.
3. Mark Pinney, Aerodynamics of Missiles and Rockets, McGraw-Hill Professional, 2014.

AAE 5303: AIRCRAFT PROPULSION [2 1 0 3]

Introduction to Propulsion, Fundamentals of incompressible and compressible flows, Propellar fundamentals, piston prop engines for aircraft, real cycle thermodynamic analysis, jet engine cycles for aircraft propulsion, jet engine components and their performance, Combustion systems

References:

1. Kroes Michael J; Wild Thomas W; Aircraft Powerplants; 2010(7 Ed), Tata-Mcgraw-Hill.
2. Roy Bhaskar, Aircraft Propulsion, 2008, Elsevier (India),
3. Mattingly J D , Elements of Propulsion - Gas Turbines and Rockets, 2006, AIAA Education series.
4. El-Sayed Ahmed, Aircraft Propulsion and gas Turbine Engines , 2008, Taylor and Francis (CRC press).
5. Saravanamuttoo, H.I.H., Rogers G.F.C., Cohen H. Gas Turbine Theory, 2001, Pearson.
6. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.

THIRD AND FOURTH SEMESTER

AAE 6091: PROJECT WORK AND INDUSTRIAL TRAINING [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.