Indian Institute of Space Science and Technology

Thiruvananthapuram

B.Tech. Aerospace Engineering

Curriculum & Syllabus (For 2007 Admission)

DEPARTMENT OF AEROSPACE ENGINEERING

SEMESTER I

CODE	TITLE	L	T	P	C
MA111	Mathematics I	3	1	0	4
PH111	Physics I	2	1	0	3
CH111	Chemistry I	2	1	0	3
AE111	Basic Mechanical Engineering I	2	0	0	2
AV111	Basic Electrical and Electronics Engineering I	2	1	0	3
HS111	Communication Skills and Humanities	2	0	2	3
PH131	Physics Lab I	0	0	3	1
CH131	Chemistry Lab I	0	0	3	1
AE131	Mechanical Engineering Lab I	0	0	3	1
AE132	Engineering Drawing	1	0	3	2
AV131	Electrical and Electronics Engineering Lab I	0	0	3	1
	Total	14	4	17	24

SEMESTER II

CODE	TITLE	L	T	P	C
MA121	Mathematics II	4	1	0	5
PH121	Physics II	4	1	0	5
CH121	Chemistry II	2	1	0	3
AE121	Basic Mechanical Engineering II	3	0	0	3
AV121	Basic Electrical and Electronics Engineering II	3	0	0	3
MA141	Programming Lab	0	0	2	1
AE141	Mechanical Engineering Lab II A	0	0	6	2
AV141	Electrical and Electronics Engineering Lab II	0	0	3	1
	Total	16	3	11	23

SEMESTER III

CODE	TITLE	L	T	P	C
MA211	Mathematics III	3	1	0	4
AE211	Engineering Thermodynamics	3	1	0	4
AE212	Mechanics of Solids	3	1	0	4
AE213	Fluid Mechanics	3	1	0	4
AE214	Metallurgy and Materials Science	3	0	0	3
AE215	Engineering Mechanics	3	0	0	3
AE231	Machine Drawing	0	0	3	1
	Total	18	4	3	23

SEMESTER IV

CODE	TITLE	L	T	P	C
MA221	Mathematics IV	3	1	0	4
AE221	Aerodynamics	3	1	0	4
AE222	Heat Transfer	3	1	0	4
AE223	Mechanisms and Machine Theory	3	1	0	4
AE224	Manufacturing Technology I	3	0	0	3
CH221	Environmental Science and Engineering	2	0	0	2
AE241	Thermal and Fluid Lab	0	0	3	1
	Total	17	4	3	22

SEMESTER V

CODE	TITLE	L	T	P	C
MA311	Mathematics V	3	0	0	3
AE311	Gas Dynamics	3	0	0	3
AE312	Aerospace Structures	3	0	0	3
AE313	Metrology and Computer Aided Inspection	3	0	0	3
AV316	Instrumentation and Control Systems	3	0	0	3
HS311	Introduction to Social Science and Ethics	2	0	0	2
AE331	Modeling and Analysis Lab	0	0	3	1
AV335	Instrumentation and Control Systems Lab	0	0	3	1
	Total	17	0	6	19

SEMESTER VI

CODE	TITLE	L	T	P	C
AE321	Flight Mechanics	3	0	0	3
AE322	Spaceflight Mechanics	3	0	0	3
AE323	Air-Breathing Propulsion	3	0	0	3
AE324	Manufacturing Technology II	3	0	0	3
E01	*Stream Elective I*	3	0	0	3
HS321	Principles of Management Systems	3	0	0	3
AE341	Aerodynamics and Flight Mechanics Lab	0	0	3	1
AE342	Manufacturing Processes Lab	0	0	3	1
	Total	18	0	6	20

SEMESTER VII

CODE	TITLE	L	T	P	C
AE411	Rocket Propulsion	3	0	0	3
AE412	Aerospace Vehicle Design	3	0	0	3
E02	*Stream Elective II*	3	0	0	3
E03	*Stream Elective III*	3	0	0	3
E04	*Department Elective*	3	0	0	3
E05	*Institute Elective*	3	0	0	3
AE431	Aerospace Structures Lab	0	0	3	1
AE432	Metrology Lab	0	0	3	1
AE451	Summer Internship and Training	0	0	0	3
AE452	Seminar	0	0	0	2
	Total	18	0	6	25

SEMESTER VIII

CODE	TITLE	L	T	P	C
AE453	Comprehensive Viva-Voce	0	0	0	3
AE454	Project Work	0	0	0	12
	Total	0	0	0	15

SEMESTER–WISE CREDITS

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	24	23	23	22	19	20	25	15	171

LIST OF ELECTIVES

Stream I	Aerodynamics and Flight Mechanics
Stream II	Materials and Manufacturing
Stream III	Design and Structures
Stream IV	Thermal and Propulsion

CODE	TITLE	Stream I	Stream II	Stream III	Stream IV
AE461	Advanced Aerodynamics	√			
AE462	Advanced Aerospace Structures			√	
AE463	Advanced Fluid Mechanics	√			√
AE464	Advanced Heat Transfer				√
AE465	Advanced Propulsion Systems				√
AE466	Aeroelasticity	√		√	
AE467	Analysis and Design of Composite Structures			√	
AE468	Computational Fluid Dynamics	√			√
AE469	Computer Integrated Manufacturing		√		
AE470	Design of Aerospace Structures			√	
AE471	Convection Heat Transfer				√
AE472	Experimental Aerodynamics	√			
AE473	Finite Element Method	√	√	√	√
AE474	Fracture Mechanics			√	
AE475	Engineering Vibration			√	
AE476	Industrial Engineering		√		
AE477	Fundamentals of Combustion				√
AE478	Supply Chain Management		√		
AE479	Introduction to Optimization	√	√	√	√
AE480	Nontraditional Machining		√		
AE481	Operations Research		√		
AE482	Project Management		√		
AE483	Robot Mechanisms and Motion Planning		√	√	
AE484	Space Mission Design and Optimization	√			√

CODE	TITLE	Stream I	Stream II	Stream III	Stream IV
AE485	Quality Engineering and Management		√		
AE486	Refrigeration and Cryogenics				√
AE487	Turbomachines				√
AE488	Advanced Manufacturing and Automation		√		
AE489	Aerospace Materials and Processes		√		
AE490	Heat Transfer in Space Applications				√
AE491	Structural Dynamics			√	
AE492	Tool Engineering and Design		√		

SEMESTER I

MA111 MATHEMATICS I (3 – 1 – 0) 4 credits

Calculus and Differential Equations:

Calculus: Taylor's theorem, partial differentiation, maxima and minima by using Lagrangian multipliers – improper integrals – applications of differentiation and integration, concavity and convexity of a curve, points of inflection, asymptotes, curvature, curve tracing – lower and upper integrals, the Riemann integral and its properties – the fundamental theorem of calculus, disorientation, mean-value theorems – double and triple integrals – change of variables in integrals, polar and spherical transforms, Jacobians of transformations – differentiation under integral sign.

Differential Equations: introduction to mathematical modelling and simulation – first order differential equations – classification of differential equations, linear, nonlinear, homogeneous and nonhomogeneous, constant coefficient and variable coefficient equations – Hadamard's problem, existence and uniqueness of solution of $y' = f(x, y)$ – higher order linear differential equations with constant coefficients – solutions of second order system with forcing terms – method of variation of parameters and method of undetermined coefficients.

Series Solutions to Differential Equations: real numbers, sequence of real numbers – limits, series, convergence of series – power series solutions to differential equations – regular singular points – Frobeneous method to solve variable coefficient differential equations – special functions of mathematical physics, Legendre polynomials, Bessel's functions, Gamma function and their properties – Sturm–Liouville problems – self adjoint operators – Green's functions.

Textbooks:

1. Kreyszig, E., *Advanced Engineering Mathematics*, 9th ed., John Wiley, 2005.
2. Stewart, J., *Calculus: Early Transcendentals*, 5th ed., Brooks/Cole, 2007.

References:

1. Simmons, G. G., *Differential Equations with Historical Notes*, Tata McGraw-Hill, 1972.
2. Thomas, G. B. and Finney, R. L., *Calculus and Analytic Geometry*, 9th ed., Pearson Education, 2003.
3. Jain, R. K. and Iyengar, S. R. K., *Advanced Engineering Mathematics*, Narosa, 2005.
4. Borelli, R. L., *Differential Equations: A Modelling Perspective*, 2nd ed., Wiley, 2004.
5. Hildebrand, F. B., *Advanced Calculus for Applications*, Prentice Hall, 1962.
6. Bear, H. S. *Understanding Calculus*, 2nd ed., John Wiley, 2003.
7. Murray, D. A., *Advanced Engineering Mathematics*, Pearson Education, 2007.
8. Protter, M. H., *Basic Elements of Real Analysis*, Spriger-Verlag, 1998.
9. Apostol, T. M., *Calculus*, Vol. I, 2nd ed., John Wiley, 1967.

Essentials of Physics:

Physics as Natural Philosophy: making observations, accuracy of observation, making measurements – creation of hypothesis and verification – units and dimensions – error analysis.

Mechanics and Gravitation: solar system – geocentric and heliocentric theories – planetary orbits – Kepler's laws Newton's laws of motion – Galilean invariance – concepts of inertia – momentum, force, work and energy – conservation laws – gravitation – Newton's inverse square law.

Optics: understanding of light phenomenon – corpuscular and wave theories of light – reflection, refraction, interference, diffraction, polarization, dispersion – lenses and mirrors – telescope, microscope, human eye, lasers.

Oscillations and Waves: damped and forced oscillations – coupled oscillators – travelling waves – superposition of waves – wave energy, energy transfer by waves – sound waves, Doppler effect.

Heat and Temperature: heat transfer – laws of thermodynamics – connection between heat and statistical behavior of molecules – kinetic theory – disorder and concept of entropy.

Electricity and Magnetism: electric and magnetic properties of materials – relationship between electricity and magnetism – electromagnetic waves.

Relativity: constancy of speed of light – relativity, relativity principle – Lorentz contraction and time dilation – mass-energy relation.

Quantum Mechanics: black-body radiation – inadequacy of classical mechanics, quantum theory – Planck's law – light quantum – photoelectric effect – wave particle duality, de Broglie hypothesis – formulation of quantum mechanics, probability interpretation, Heisenberg's uncertainty principle, Schrodinger's equation.

Textbooks:

1. Serway, R. A. and Jewett, J. W., *Principles of Physics: A Calculus Based Text*, 4th ed., Thomson Brooks/Cole, 2006.
2. Halliday, D., Resnick, R., and Walker, J., *Fundamentals of Physics*, 6th ed., John Wiley, 2001.

References:

1. Young, H. D. and Freedman, R. A., *Sears and Zemansky's University Physics*, 11th ed., Pearson Education, 2004.
2. Feynman, R. P., Leighton, R. B., and Sands, M., *The Feynman Lectures on Physics*, Narosa Publishing House, 1986.
3. Beiser, A., *Concepts of Modern Physics*, 6th ed., Tata McGraw-Hill, 2003.

4. Ghatak, A., *Optics*, 3rd ed., Tata McGraw-Hill, 2005.
5. Tipler, P. A., *Physics for Scientists and Engineers*, 4th ed., W. H. Freeman, 1998.
6. Leighton, R. B., *Principles of Modern Physics*, International Series of Pure and Applied Physics, 1959.
7. Giancoli, D. C., *Physics: Principles with Applications*, 6th ed., Prentice Hall, 2004.

CH111 CHEMISTRY I (2 – 1 – 0) 3 credits

Basic Concepts of Chemical Bonding: different types of bonds (structure and boding-hybridization - VSEPR etc. VB and MO).

Organic Chemistry: classification of compounds – aliphatic and aromatic synthesis and reactions of saturated and unsaturated compounds – isomerism – functional groups and types of reactions.

Spectroscopy: general features – fundamentals of UV-VIS and IR spectroscopy – Beer–Lambert's law – electronic absorption and emission spectroscopy – introduction to important spectroscopic techniques.

Thermodynamics: laws of thermodynamics – concept of internal energy and entropy – thermodynamics of chemical reactions.

Electrochemical Systems: electrochemical cells and EMF, applications of EMF measurements – thermodynamic data, activity coefficients, solubility product and PH.

Polymer Chemistry: monomers, polymeriozability – degree of polymerization, molecular weights, thermal transitions – classification of polymers – method of polymerization – step growth and addition (free radical, ionic) – introduction to copolymers, block and graft copolymers – polymers for space applications.

Chemical Engineering: laboratory and industrial manufacture of chemicals – unit process and unit operations – technical and economic feasibility – block diagrams and process flow diagrams – material and energy balances – industrial reactors – manufacture of ammonia – petroleum refining.

Propellants and Explosives: primary and secondary explosives, RDX, HMX, plastic bonded explosives, initiators, detonators – explosion, detonation – classification of propellants – solid, liquid and hybrid propellants.

Textbooks:

1. Jain, P. C. and Jain, M., *Engineering Chemistry*, 15th ed., Dhanpat Rai, 2007.
2. Krishnamurthy, N., Vallinayagam, P., and Madhavan, D., *Engineering Chemistry*, Prentice Hall of India, 2007.

References:

1. Atkins, P. and de Paula, J., *Atkins' Physical Chemistry*, 8th ed., Oxford Univ. Press, 2007.
2. Kuriakose, J. C. and Rajaram, J., *Chemistry in Engineering & Technology*, Vol. I, Tata McGraw-Hill, 1984.
3. Bruice, P. Y., *Organic Chemistry*, Pearson Education, 2006.
4. Lee, J. D., *Concise Inorganic Chemistry*, 5th ed., Blackwell Science, 2007.
5. Young, R. J. and Lovell, P. A., *Introduction to Polymers*, 2nd ed., Chapman & Hall, London, 1991.
6. McCabe, W. L. Smith, J. C., and Harriott, P., *Unit Operations of Chemical Engineering*, 7th ed., McGraw-Hill, 2005.
7. Urbenskey, T., *Chemistry and Technology of Explosives*, Vol. 2, Vol. 3 and Vol. 4, Pergamon Press, 1988.

AE111 BASIC MECHANICAL ENGINEERING I (2 – 0 – 0) 2 credits

Introduction to Mechanical Engineering: mechanical systems, examples – role of mechanical engineering in industry with emphasis on aerospace industry – a historical overview of evolution of mechanical systems.

Materials: introduction engineering materials – different types of metals, alloys and composites – basic mechanical properties.

Manufacturing Processes: basics of conventional design and manufacturing processes – concept of concurrent engineering.

Engineering Measurements and Control: uses, functions of an instrument – performance characteristics – zero and first order instruments – errors – control systems.

Metrology: standards; line, end and wavelength standards – geometric dimensioning and tolerancing – Indian standards – metrology in quality assurance.

Prime mover Technologies.

Textbook:

- Lecture Notes.

References:

1. Shanmugham, G., *Introduction to Mechanical Engineering*, Tata McGraw-Hill, 2007.
2. Sawhney, G. S. and Schmidt, S. R., *Fundamentals of Mechanical Engineering: Thermodynamics, Mechanics and Strength of Materials*, Prentice Hall of India, 2001.
3. Doebelin, E. D., *Measurement Systems: Applications and Design*, 5th ed., Tata McGraw-Hill, 2007.

4. Murthy, V. S. R., *Structure and Properties of Engineering Materials*, Tata McGraw-Hill, 2007.
5. Rao, P. N., *Manufacturing Technology*, Tata McGraw-Hill, 2007.
6. Çengel, Y. A. and Boles, M. A., *Thermodynamics*, 5th ed., Tata McGraw-Hill, 2007.

AV111 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING I (2 – 1 – 0) 3 credits

Elementary DC Circuite: Kirchhoff's current law and voltage law – basic circuits elements; resistors, capacitors, inductors.

Basic Circuits Analysis Methods: nodal, mesh, and modified nodal-analysis – network theorems; Tellegen's theorem, superposition theorem, Thevenin's theorem and Norton's theorems, substitution theorems, reciprocity theorem, maximum power-transfer theorem.

Analysis of Simple AC Circuits: phasors, phasor diagrams – impedance and admittance concepts – power measurement in 1 and 3 phase AC circuits – active and reactive power – power factor – series and parallel resonance, Q factor – step response and transient analysis of RL, RC, and RLC circuits.

Basic Electronics: semiconductor diode characteristics and applications in rectifiers and power suppliers – transistor characteristics – biasing circuit – small signal and low frequency transistor model – field effect devises – JFET/HEFT MOSFET operation.

Textbooks:

1. Hughes, E., *Electrical and Electronic Technology*, Pearson Education, 2002.
2. Boylestad, R. L. and Nashelsky, L., *Electronic Devices and Circuit Theory*, Pearson Education, 2003.

References:

1. Hayt, W. H. and Kemmerley, J. E., *Engineering Circuit Analysis*, 4th International Student Edition, McGraw-Hill, 1986.
2. Murthy, K. V. V. and Kamath, M. S., *Basic Circuit Analysis*, Reprinted, Jaico Publishing, 1998.
3. Del Toro, V., *Principles of Electrical Engineering*, 2nd ed., Prentice Hall, 1986.
4. Kothari, D. P. and Nagrath, I. J., *Theory and Problems of Basic Electrical Engineering*, Prentice Hall, 2000.
5. Mottershed, A., *Electronics Devices and Circuits – An Introduction*, 12th ed., Reprint, EEE Publication, 1989.
6. Bapat, Y. N., *Electronic Device and Circuits*, 9th Reprint, Tata McGraw-Hill, 1989.
7. Malvino, A. P., *Electronics Principles*, 3rd TMH ed., Tata McGraw-Hill, 1989.
8. Floyd, T. L., *Electronic Device*, Pearson Education, 1996.

Economics for a Developing World

Principles and Concepts:

Economics: definitions, importance, schools of thought, resource allocation, its nature and importance for developing countries.

Economic Systems: basics of capitalism, socialism, mixed economy, market economy and third world economies.

Basic Concepts and Principles: micro and macro economics – demand and supply – elasticity, production- factors of production and production function, costs- TC, AC, MC and OC, VC, FC – short run and long run costs – market- basics of perfect competition, monopoly, monophony and oligopoly – concept of equilibrium – consumer surplus – national income and BOP.

Economic Problems and Policies:

Developing countries and developed countries, differences, characteristics, LDCs.

Meaning of Development: development Vs growth – Measuring development – problems of growth – lessons and controversies – Indian situation.

Poverty and Inequality: vicious circle of poverty.

Population and Development: demographic transition theory, optimum population, importance of population, problems of population growth.

Agriculture and Rural Development: importance, problems, agrarian conditions in India.

Development Planning: theory and practice:

Meaning of planning – importance, types, case for and against planning – objectives and strategies of planning – methodology of planning – India's planning experience – planning commission, NDC – brief review of five year plans – achievements and problems.

Textbooks:

1. Dewett K. K., *Modern Economic Theory*, S. Chand, 1966.
2. Sowell, T., *Basic Economics: A Citizen's Guide to Economy*, Blackstone Audiobooks, 2006.
3. Lipsey, R. and Alec, C. K., *Economics*, 10th ed., Oxford Univ. Press, 2003.
4. Thirlwall A. P., *Growth and Development with Special References to Developing Economics*, Macmillan, 2003.
5. Sundaram K. P. M. and Dutt, R., *Indian Economy*, S. Chand, 1967.
6. Lekhi, R. K., *Economics of Development and Planning*, Kalyani Publishers, 2002.

References:

1. Meir, G. M. and Rauch, J. E., *Leading issues in Economic Development*, Oxford Univ. Press, 2005.
2. Todao, M. P. and Smith, S. C., *Economic Development*, Addison-Wesley, 2005.
3. Aggarwal A. N., *Indian Economy, Problems of Development and Planning*, Wiley Eastern, 1992.
4. Pearce, D. W., *McMillan Dictionary of Modern Economics*, Palgrave Macmillan, 1992.
5. O'Connor, D. E., *The Basics of Economics*, Greenwood, 2004.
6. Kapila, U., *Indian Economy Science Independence*, Academic Foundation, 2004.
7. Misra, S. K. and Puri, V. K., *Indian Economy: Its Development Experience*, Himalaya Publishing House, 1989.

Communications Skills

Introduction to phonetics and organs of speech – phonetic script – practice of sounds in the language lab – pronunciation drills with emphasis on stress, rhythm and intonation – learning skills, conservational skills, reading skills along with interactive and interpersonal skills.

Basics of grammar – vocabulary exercises – group discussion – teaching language through visual aids like photographs – audio-video clippings or movies and exercises in augmenting conversational skills.

Textbooks:

1. Brown, S. and Smith, D., *Active Listening with Speaking*, Cambridge Univ. Press, 2007.
2. Carter, R. and McCarthy, M., *Cambridge Grammar of English*, Cambridge Univ. Press, 2006.

References:

1. Baker, A. and Goldstein, S., *Pronunciation Pairs: An Introductory Course for Students of English*, Cambridge Univ. Press, 1990.
2. Ladousse, G. P., *Speaking Personally*, Cambridge Univ. Press, 1983.
3. Murphy, R., *Essential Grammar in Use*, 3rd ed., Cambridge Univ. Press, 2004.
4. Baker, A., *Ship or Sheep: An Intermediate Pronunciation Course*, 3rd ed., Cambridge Univ. Press, 2006.
5. Hewings, M., *Advanced Grammar in Use*, 2nd ed., Cambridge Univ. Press, 2005.

PH131 PHYSICS LAB I (0 – 0 – 3) 1 credit

CH131 CHEMISTRY LAB I (0 – 0 – 3) 1 credit

AE131 MECHANICAL ENGINEERING LAB I (0 – 0 – 3) 1 credit

AE132 ENGINEERING DRAWING (1 – 0 – 3) 2 credits

Introduction to Engineering Drawing and Graphics: lettering, paper sizes, types of pencils, drawing conventions, scales – dimensioning principles and conventions – construction of plane curves, cycloid, hypocycloid, involutes, ellipses, parabola, hyperbola.

Projection of Points and Lines: projection of points, lines, and planes – projection of solids (orthographic, isometric) – sections of solids – intersection of solids – development of solids.

Introduction to CAD: model and paper spaces – local and global co-ordinate systems – views – creation of simple 2D drawings – introduction to GD & T – creation of dimensions and tolerances in CAD – creation of simple drawing – detailing – plotting solid modeling of simple components – auxiliary projections – sectional views.

Textbooks:

1. Siddiquee, A. N., Khan, Z. A., and Ahmad, M., *Engineering Drawing with a Primer on AutoCAD*, Prentice Hall of India, 2004.
2. Varghese, P. I., *Engineering Graphics*, VIP Publishers, 2007.

References:

1. Gill, P. S., *Engineering Graphics and Drafting*, S.K. Kataria & Sons, 2006.
2. Bethune, J. D., *Engineering Graphics with AutoCAD*, Prentice Hall, 2007.
3. Maguire, D., *Engineering Drawing from First Principles using AutoCAD*, Butterworth-Heinemann, 1998.

AV131 ELECTRICAL AND ELECTRONICS ENGINEERING LAB I (0 – 0 – 3) 1 credit

SEMESTER II

MA121 MATHEMATICS II (4 – 1 – 0) 5 credits

Vector Calculus, Linear Algebra and Numerical Analysis:

Vector Calculus: scalar and vector fields – level surfaces – directional derivatives, gradient, curl, divergence – Laplacian – line and surface integrals – theorems of Green, Gauss and Stokes – orthogonal curvilinear coordinates – operators in cylindrical and spherical coordinates.

Vector Spaces and Linear Transformation on R^n: group, ring and field – vector spaces, subspaces – linear dependence and independence – basis, dimension, inner product – Gram–Schmidst orthogonalization process – linear transformations – null-space and nullity – range space and rank of linear transformation.

Matrix Representation of Linear Transformation: solution space of system of equation $Ax = b$ – inverse of linear operators – similar matrices – eigenvalues and eigenvectors – Cayley–Hamilton theorem – bounds on eigenvalues – Hermitian, skew-Hermitian – unitory and normal matrices (including symmetric, skew-symmetric, and orthogonal matrices) – positive/negative definite and semi-definite matrices – quadratic form.

Numerical Solution of Algebraic and Transcendental Equations: iterative method – bisection method and Newton–Raphson method.

Solution of System of Linear Equations: direct method – Gauss elimination method – iterative methods – Jacobi and Gauss–Seidel methods.

Numerical Integration: trapezoidal method – Simpson's 1/3 rule, Simpson's 3/8 rule.

Solution of Ordinary Differential Equations: predictor-corrector method – Runge–Kutta method for first order and higher order equations.

Interpolation and Curve Fitting: finite differences, Forward, Backward and Central Differences, Newton's forward difference, backward difference and central difference interpolation polynomials, Lagrange polynomials, Linear interpolation, Least square curve, cubic splines, etc.

Textbooks:

1. Kreyszig, E., *Advanced Engineering Mathematics*, 9th ed., John Wiley, 2005.
2. Jain, R. K. and Iyengar, S. R. K., *Advanced Engineering Mathematics*, Narosa, 2005.

References:

1. Stewart, J., *Calculus: Early Transcendentals*, Brooks/Cole Pub. Co., 2007.
2. Herstein, I. N., *Topics in Algebra*, Wiley Eastern, 2003.
3. Lang, S., *Linear Algebra*, 3rd ed., Springer, 1987.
4. Sastry, S. S., *Introductory Methods of Numerical Analysis*, Prentice Hall India, 2002.
5. Atkinson, K., *Numerical Analysis*, Prentice Hall, 2005.

6. Conte, S. D. and deBoor, C., *Numerical Analysis*, McGraw-Hills, 1994.
7. Gerald, C. F. and Wheatley, P. O., *Applied Numerical Analysis*, Pearson, 2004.
8. Bronson, R., *Schaums Outlines on Matrix Operations*, 1988.
9. Gantmacher, F. R., *Applications of the Theory of Matrices*, Chelsea, 2005.
10. Krishnamurthy V., *Introduction to Linear Algebra*, East-West Press, 1976.

PH121 PHYSICS II (4 – 1 – 0) 5 credits

Part I

Vector Calculus: use of vectors in practical mechanics – unit vectors in spherical and cylindrical polar coordinates – conservative vector fields and their potential functions – gravitational and electrostatic examples – gradient of a scalar field – equipotentials, states of equilibrium – work and energy, conservation of energy – motion in a central force and conservation of angular momentum – physics concepts in vector fields – continuity equations and conservation principles for matter – energy and molecular charge – flux, divergence of a vector – Gauss' theorem, physical applications in gravitation and electrostatics – irrotational versus rotational vector fields – physical significance of circulation, curl of a field – Stokes' theorem, physical applications – oscillatory motion, wave motion – group velocity and dispersion – shallow water waves – wave equation in three dimensions – spherical waves.

Electromagnetic Theory: electrostatic potential and field due to discrete and continuous charge distributions – dipole and quadrupole moments – energy density in an electric field – dielectric polarization – conductors and capacitors – electric displacement vector, dielectric susceptibility – Biot–Savart's law and Ampere's law in magnetostatics – magnetic induction due to configuration of current-carrying conductors – magnetization and surface currents – energy density in a magnetic field – magnetic permeability and susceptibility – force on a charge particle in electric and magnetic fields – time-varying fields – Faraday's law of electromagnetic induction – self and mutual inductance – resonance and oscillation in electric circuits – displacement current – Maxwell's equations in free space and in linear media – scalar and vector potentials, gauges – plane electromagnetic waves – electromagnetic energy density – Pointing vector – wave guides.

Textbooks:

1. Griffith, D. J., *Introduction to Electrodynamics*, 3rd ed., Prentice Hall, 1999.
2. Kleppner, D. and Kolenkow, R. J., *An Introduction to Mechanics*, McGraw-Hill, 1973.

References:

1. Kittel, C., Knight, W. D., and Ruderman, M. A., *Mechanics – Berkeley Physics Course*, Vol. 1, McGraw-Hill, 1965.
2. Purcell, E. M., *Electricity and Magnetism, Berkeley Physics Course*, Vol. 2, Tata McGraw-Hill, 1981.

3. Crawford, F. S., *Waves and Oscillations, Berkeley Physics Course*, Vol. 3, McGraw-Hill, 1968.
4. Feynman, R. P., Leighton, R. B., and Sands, M., *The Feynman Lectures on Physics*, 3rd ed., Narosa, 1986.
5. Reitz, J. R., Milford, F. J., and Christy, R. W., *Foundations of Electromagnetic Theory*, Narosa, 1998.
6. Wangsness, R. K., *Electromagnetic Fields*, 2nd ed., Wiley, 1986.
7. Spiegel, M. R., *Schaum's Outline of Vector Analysis*, McGraw-Hill, 1968.

Part II

Introduction to Astronomy: coordinate system – electromagnetic spectrum, flux – magnitude scale – interstellar reddening – telescopes – stellar spectrum, H-R diagram – interstellar medium – star formation and evolution – solar system – cosmology.

Introduction to Atmospheric Physics: earth's atmosphere, structure, classification, constituents – greenhouse effect – radiation budget – differential heating – general circulation – cloud formation and classification – sun and solar radiation – interaction with planetary atmosphere.

Introduction to Space Technology: basic of orbital mechanics – conic sections – orbital elements – types of orbits – motion of planets and satellites – launch of a space vehicle – position in an elliptical orbit – orbit perturbation – orbit maneuvers.

References:

1. Carroll, B. W. and Ostlie, D. A., *An Introduction to Modern Astrophysics*, Addison-Wesley, 1996.
2. Shu, F. H., *The Physical Universe: An Introduction to Astronomy*, University Science Books, 1982.
3. Palen, S., *Schaum's Outline Series on Astronomy*, McGraw-Hill, 2001.
4. Narlikar, J. V., *Introduction to Cosmology*, 3rd ed., Cambridge Univ. Press, 2002.
5. Wallace, J. M. and Hobbs, P. V., *Atmospheric Science: An Introductory Survey*, Academic Press, 2006.
6. Houghton, J. T., *The Physics of Atmosphere*, 3rd ed., Cambridge Univ. Press, 2002.
7. Goody, R. M., Walker, J. C. G., and Lee, M. A., *Atmospheres*, Prentice Hall, 1972.
8. Iqbal, M., *Introduction to Solar Radiation*, Academic Press, 1983.
9. Das, P. K., *The Monsoons*, World Meteorological Organization, 1986.
10. Rishbeth, H. and Garriott, O. K., *Introduction to Ionospheric Physics*, Academic Press, 1969.
11. Curtis, H. D., *Orbital Mechanics for Engineering Students*, Butterworth-Heinemann, 2004.

Chemical Kinetics: basic concepts of chemical kinetics – reaction stoichiometry – rates of consumption and formation – extent of reaction – rate of reaction – volume change during reaction – empirical rate equations – elementary, composite and chain reactions – catalysis and inhibition – first order reactions, second order reactions, reactions of n^{th} order – half life – influence of temperature on reaction rates – Arrhenius equation.

Dynamics of Chemical Processes: basic concepts – composite reactions – opposing, parallel, and consecutive reactions – reaction mechanisms – chain reactions (stationary and non-stationary) – enzyme kinetics – theories of reaction rates (collision theory and classical transition state theory) – unimolecular reactions.

Electrochemistry: weak and strong electrolytes – specific conductance, equivalent conductance – activity – ionic strength – ionic atmosphere – Kohlrausch law – Arrhenius theory of electrolyte dissociation – Ostwald's dilution law – determination of degree of dissociation – transport number – Hittorf method, moving boundary method – electrochemical series – thermodynamic quantities of cell, conservation cell – determination of K_a, K_{sp} – conductometric titration – potentiometric titration – determination of pH.

Corrosion: theories of corrosion – chemical corrosion, electrochemical corrosion, galvanic cell corrosion, pitting corrosion, inter granular corrosion, water line corrosion, stress corrosion – factors influencing corrosion – testing and measurement of corrosion – protection against corrosion, protective coatings- metallic, nonmetallic and organic coatings.

Spectroscopic Techniques: NMR spectroscopy and Mass spectroscopy.

Thermal Characterization Techniques: Thermo-Gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Differential Thermal Analysis (DTA).

Surface Characterization: Electron Spectroscopy for Chemical Analysis (ESCA), Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), and Transmission Electron Microscopy (TEM).

Advanced Composite Materials: general characteristics and applications of composite materials – classifications of composites – metal- matrix composites, ceramic- matrix composites, nano-composites – factors influencing composite properties – Fiber Reinforced Polymer (FRP) – types of fibers – composite processing techniques like bag moulding, compression moulding, pulrtusion, hand lay-up, and spray lay-up.

Composite Propellants: binder systems – polysulfides, polyurethanes and polybutadiens – high-energy composite propellants.

Textbooks:

1. Jain, P. C. and Jain, M., *Engineering Chemistry*, 15th ed., Dhanpat Rai, 2007.
2. Krishnamurthy, N., Vallinayagam, P., and Madhavan, D., *Engineering Chemistry*, Prentice-Hall of India, 2007.

References:

1. Laidler, K. J., *Chemical Kinetics*, 3rd ed., Pearson Education, 2005.
2. Atkins, P., and De Paula, J., *Atkins' Physical Chemistry*, 8th ed., Oxford Univ. Press, 2007.
3. Kemp, W., *Organic Spectroscopy*, 3rd ed., Palgrave Macmillan, 2007.
4. Hull, D., *An Introduction to Composite Materials*, Cambridge Univ. Press, 1981.
5. Hong T. H. and Tsai, S. W., *Introduction to Composite Materials*, Technomic Publishing Co., 1980.
6. Skoog, D. A., West, D. M., and Holler, F. J., *Fundamentals of Analytical Chemistry*, 8th ed., Thompson Brooks/Cole, 2004.
7. Crow, D. R., *Principles and Applications of Electrochemistry*, 3rd ed., Chapman & Hall, 1988.
8. Sharma, B. K., *Instrumental Methods for Chemical Analysis*, 16th ed., Goel Publishing House, 1997.
9. Dodd, J. W. and Tonge, K. H., *Thermal Methods*, John Wiley, 1987.

AE121 BASIC MECHANICAL ENGINEERING II (3 – 0 – 0) 3 credits

Testing of Materials: properties – methods to evaluate mechanical properties of metallic materials.

Advanced Manufacturing Processes: automation of manufacturing process – robotics – mechatronics.

Mechanisms: mechanism and their role – introduction to simulation and analysis in design and manufacturing.

Combustion: combustion thermodynamic – fundamentals of combustion kinetics.

Heat Transfer: steady and unsteady state conduction in one-dimensional systems – convection and radiation heat transfer.

Analysis of Experimental Data: uncertainty analysis – probability distribution of errors – regression analysis.

Introduction to Space Systems: history – classification – subdivisions of aerospace engineering – Indian aerospace activities.

Textbook:

- Lecture Notes

References:

1. Çengel, Y. A., *Heat and Mass Transfer*, 3rd ed., Tata McGraw-Hill, 2007.
2. Kalpakjian, S. and Schmid, S. R., *Manufacturing Engineering and Technology*, 4th ed., Prentice Hall, 2001.

3. Çengel, Y. A. and Boles, M. A., *Thermodynamics*, 3rd ed., Tata McGraw-Hill, 2007.
4. Rattan, S. S., *Theory of Machines*, 2nd ed., Tata McGraw-Hill, 2007.
5. Nayar, A., *Testing of Metals*, Tata McGraw-Hill, 2007.
6. Holman, J. P., *Experimental Methods for Engineers*, 7th ed., Tata McGraw-Hill, 2004.
7. Anderson Jr., J. D., *Introduction to Flight*, 5th ed., Tata McGraw-Hill, 2007.

AV121 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING II (3 – 0 – 0) 3 credits

Magnetic Circuits: properties of magnetic circuits – dc excitation – hysteresis loop, B-H curve, reluctance – air gap – iterative design – ac excitation – eddy current losses – energy in magnetic field – production of force, EMF – relays.

Transformer: equivalent circuits – auto transformer – efficiency and voltage regulation – SC and OC test.

Electro-Mechanical Energy Conversion: principles of rotating machines – DC motors and generators, principle of operation, speed torque characteristics, speed control – alternators and induction motors, operating principle, equivalent circuit, speed torque characteristics – no-load test.

Operational Amplifiers: introduction, parameters and characteristics – differential amplifier – differential and common mode operation common mode rejection ratio (CMRR) – inverting and inverting mode and its operation – typical applications of op-amps in analog computations – adder, subtractor, comparator, differentiator, integrator – active filters, first order and second order low pass and high pass filter.

Digital Circuits: introduction – Boolean algebra – basic logic gates – implementation of basic gates using universal gates – combinational circuits – half adder, full adder – sequential circuits – flip-flops.

Introduction to Microprocessors: architecture of 8 bit microprocessor (8085) – introduction to assembly language programming – computer architecture – functional block diagram.

Power Semiconductor Devises: SCR, TRIAC, DIAC, UJT, working characteristics – typical applications in DC/Dc convertors, invertors, UPS.

Transducers: working principle – applications in aerospace – use of thermistors.

Storage Batteries: different technologies – characteristics, specifications, maintenance – usage in aerospace applications.

Principles of Communication: need for modulation, types of modulation (AM, FM, PM) – basic block diagram of a communication system – overview of satellite communication.

Textbooks:

1. Del Toro, V., *Principles of Electrical Engineering*, 2nd ed., Prentice Hall, 1986.
2. Floyd, T. L., *Digital Fundamentals*, 8th ed., Pearson Education, 2005.

References:

1. Pal, M. A., *Introduction to Electrical Circuits and Machines*, Affiliated East-West Press, 1975.
2. Say, M. G., *Performance and Design of AC Machines*, CBS Publishers, 2005.
3. Langsdorf, A. S., *The Theory of Alternating Current Machinery*, Tata McGraw-Hill, 1999.
4. Milman, J. and Halkias, C. C., *Integrated Electronics - Analog and Digital Systems*, McGraw-Hill, 1972.
5. Taub, H. and Schilling, D. L., *Digital Integrated Electronics*, McGraw-Hill, 1977.
6. Hodges, D. A. and Jackson, H. G., *Analysis and Design of Digital Integrated Circuits*, McGraw-Hill, 1983.
7. Kassakian, J. G., Schlecht, M. F., and Verghese, G. C., *Principles of Power Electronics*, Prentice Hall, 1991.
8. Erickson, R. W., *Fundamentals of Power Electronics*, Chapman & Hall, 1997.
9. Mohan, N., Undeland, T., and Robbins, W., *Power Electronics: Convertors, Applications and Design*, 2nd ed., John Wiley, 1995.
10. Jain, R. P., *Modern Digital Electronics*, Tata McGraw-Hill, 2003.
11. Mano, M. M., *Digital Design*, Prentice Hall, 2002.
12. Gaonkar, R. S., *Microprocessor Architecture – Programming, and Applications with the 8085*, Prentice Hall, 2002.
13. Hughes, E., *Electrical and Electronic Technology*, Pearson Education, 2002.
14. Gayakward, R. A., *Op-Amps and Linear Integrated Circuits*, Prentice Hall, 1992.
15. Kennedy, G., *Electronic Communication Systems*, McGraw-Hill, 1977.

MA141	PROGRAMMING LAB	(0 – 0 – 2) 1 credit

AE141	MECHANICAL ENGINEERING LAB II A	(0 – 0 – 6) 2 credits

AV141	ELECTRICAL AND ELECTRONICS ENGINEERING LAB II	(0 – 0 – 3) 1 credit

SEMESTER III

MA211 MATHEMATICS III (3 - 1 - 0) 4 credits

Complex Analysis, Fourier Series and Integral Transforms:

Complex Variable: complex numbers and their geometrical representation – functions of complex variable – limit, continuity and derivative of functions of complex variable – analytical functions and applications – harmonic functions – transformations and conformal mappings – bilinear transformation – contour integration and Cauchy's theorem – convergent series of analytic functions – Laurent and Taylor series – zeroes and singularities – calculation of residues – residue theorem and applications.

Fourier Series: Fourier series expansion of periodic functions with period two – Fourier series of even and odd functions – half-range series – Fourier series of functions with arbitrary period – conditions of convergence of Fourier series.

Laplace Transform: Laplace transforms of elementary functions – inverse Laplace transforms – linearity property – first and second shifting theorem – Laplace transforms of derivatives and integrals – Laplace transform of Dirac delta function – applications of Laplace transform in solving ordinary differential equations.

Fourier Transform: Fourier integral – the Fourier transform pair – algebraic properties of Fourier transform – convolution, modulation, and translation – transforms of derivatives and derivatives of transform – inversion theory.

Textbook:

- Kreyszig, E., *Advanced Engineering Mathematics*, 9th ed., John Wiley, 2005.

References:

1. Churchill, R. V. and Brown, J. W., *Complex Variables and Applications*, 6th ed., McGraw-Hill, 2004.
2. Mathews, J. H. and Howell, R., *Complex Analysis for Mathematics and Engineering*, Narosa, 2005.
3. Wylie, C. R. and Barrett, L. C., *Advanced Engineering Mathematics*, McGraw-Hill, 2002.
4. Jain, R. K. and Iyengar, S. R. K., *Advanced Engineering Mathematics*, Narosa, 2005.
5. Greenberg, M. D., *Advanced Engineering Mathematics*, Pearson Education, 2007.
6. James, G., *Advanced Modern Engineering Mathematics*, Pearson Education, 2004.

AE211 ENGINEERING THERMODYNAMICS (3 – 1 – 0) 4 credits

Basic concepts of thermodynamics – properties of pure substances – energy transfer by heat, work, and mass – first law of thermodynamics – second law of thermodynamics – entropy and exergy – gas power, vapor power, and combined cycles – refrigeration cycle – thermodynamics property relations – gas mixtures, gas-vapor mixture – air conditioning – applications in thermal engineering.

Textbook:

- Çengel, Y. A. and Boles, M. A., *Thermodynamics – An Engineering Approach*, 5th ed., Tata McGraw-Hill, 2006.

References:

1. Nag, P. K., *Engineering Thermodynamics*, 3rd ed., Tata McGraw-Hill, 2005.
2. Moran, M. J. and Shapiro, H. N., *Fundamentals of Engineering Thermodynamics*, 6th ed., Wiley, 2007.

AE212 MECHANICS OF SOLIDS (3 – 1 – 0) 4 credits

Concepts of stress, strain – compatibility – generalized Hooke's law – torsion – axial force, shear, and bending moment – pure bending – shear stress in beams – transformation of stresses and strains – deflection of beams – stability – energy methods.

Textbook:

- Popov, E. P., *Engineering Mechanics of Solids*, 2nd ed., Prentice Hall, 1998.

References:

1. Hibbeler, R. C., *Mechanics of Materials*, 6th ed., Prentice Hall, 2004.
2. Beer, F. P., Johnston, E. R., and DeWolf, J. T., *Mechanics of Materials*, 4th ed., McGraw-Hill, 2005.
3. Srinath, L. S., *Advanced Mechanics of Solids*, 2nd ed., Tata McGraw-Hill, 2003.

AE213 FLUID MECHANICS (3 – 1 – 0) 4 credits

Fluid properties – fluid statics – fluid kinematics – control volume equations (integral formulation) – differential formulation – continuity and Navier–Stokes equations – exact solutions – dimensional analysis – pipe flow – potential flow – boundary layer flow – turbulence.

Textbook:

- Fox, R. W. and McDonald, A. T., *Introduction to Fluid Mechanics*, 6th ed., John Wiley, 2003.

References:

1. Çengel, Y. A. and Cimbala, J. M., *Fluid Mechanics: Fundamental and Applications*, McGraw-Hill, 2005.
2. White, F. M., *Fluid Mechanics*, 5th ed., McGraw-Hill, 2003.
3. Kundu, P. K. and Cohen, I. M., *Fluid Mechanics*, 3rd ed., Academic Press, 2004.

AE214 METALLURGY AND MATERIALS SCIENCE (3 – 0 – 0) 3 credits

Introduction to engineering materials – structure of crystalline solids – imperfections in solids – mechanical properties of materials – plastic deformation and strengthening mechanism in materials – phase diagrams and phase transformations – fracture, fatigue, and creep – classifications and applications of selected engineering materials.

Textbooks:

1. Callister Jr., W. D., *Materials Science and Engineering – An Introduction*, 7th ed., John Wiley, 2007.
2. Dieter, G. E., *Mechanical Metallurgy*, 3rd ed., McGraw-Hill, 1988.
3. Askeland, D. R. and Phule, P. P., *The Science and Engineering of Materials*, 4th ed., Thompson-Engineering, 2006.

References:

1. Raghavan, V., *Materials Science and Engineering*, 5th ed., Prentice Hall of India, 2004.
2. Smith, W. F., *Principles of Materials Science and Engineering*, McGraw-Hill, 1990.
3. Thelning, K.-E., *Steel and Its Heat Treatment*, 2nd ed., Butterworth-Heinemann, 1984.
4. Singh, V., *Physical Metallurgy*, Standard Publishers, 1999.
5. Rajan, T. V., Sharma, C. P., and Sharma, A., *Heat Treatment: Principles and Techniques*, 2nd ed., Prentice Hall of India, 2006.
6. Van Vlack, L. H., *Elements of Materials Science and Engineering*, 6th ed., Pearson Education, 1989.

AE215 ENGINEERING MECHANICS (3 – 0 – 0) 3 credits

Basics of statics – fundamental principles and concepts – analysis of structures – trusses, frames, machines, beams, cables – friction – center of mass and area moments of inertia – mass moment of inertia – virtual work and energy method – applications of energy method for equilibrium – stability of equilibrium – review of particle dynamics – plane kinematics of rigid bodies, rotation – plane kinetics of rigid bodies – introduction to vibration.

Textbooks:

1. Timoshenko, S. P. and Young, D. H., *Engineering Mechanics*, 4th ed., Tata McGraw-Hill, 2007.
2. Beer, F. B. and Johnston, E. R., *Vector Mechanics for Engineers: Statics* (Vol. 1), *Dynamics* (Vol. 2), 8th ed., Tata McGraw-Hill, 2007.

References:

1. Meriam, J. L. and Kraige, L. G., *Engineering Mechanics: Statics* (Vol. 1), *Dynamics* (Vol. 2), 5th ed., Wiley, 2002.
2. Shames, I. H., *Engineering Mechanics: Statics and Dynamics*, 4th ed., Prentice Hall, 1996.
3. Hibbeler, R. C., *Principles of Statics and Dynamics*, 10th ed., Prentice Hall, 2006.

AE231 MACHINE DRAWING (0 – 0 – 3) 1 credit

Threaded fasteners – nuts, joints – part drawing of machine elements – couplings, computer aided drafting of machine elements – assembly drawings using CAD for various engine parts – conventions in shop floor drawings – limits, fits, and tolerances, and their interpretations – creation of assembles in solid modeling packages and preparation of 2D drawings – a drawing project on reverse engineering.

Textbook:

- Bhatt, N. D. and Panchal, V. M., *Machine Drawing*, 41st ed., Charotar Publishing House, 2006.

References:

1. Sidheswar, N., Kanniah, P., and Sastry, V. V. S., *Machine Drawing*, Tata McGraw-Hill, 1983.
2. Luzadder, W. J. and Duff, J. M., *Fundamentals of Engineering Drawing*, 11th ed., Prentice Hall, 1995.
3. John, K. C. and Varghese, P. I., *Machine Drawing*, VIP Publication, 1995.

SEMESTER IV

MA221 MATHEMATICS IV (3 – 1 – 0) 4 credits

Probability and Statistics:

Probability Distributions: random Variable, discrete and continuous random variables – probability distributions – binomial distribution, hyper geometric distribution – Poisson approximation to the binomial, geometric distribution, normal distribution – normal approximation to the binomial distribution, uniform distribution, gamma distribution, beta distribution, and Weibull distribution – mathematical expectation and moments, mean, variance, moment generating function, and characteristic function.

Sampling Distributions and Inference Concerning Means: population and samples – central limit theorem – sampling distributions of mean and variance – point estimation – confidence interval for mean, variance and proportions – tests of hypotheses, the null hypotheses and the significance tests – control charts for variables and attributes – acceptance sampling by attributes – simple, double and sequential sampling plans – design of experiments.

Correlation and Regression Analysis: curve fitting by the method of least squares – Chi-square test of goodness of fit – contingency tables – inference based on the least square estimators – regression – correlation – inference concerning correlation coefficient.

Markov Chains: stochastic processes – Markov chains with finite and countable state space – classification of states – limiting behavior of n-step transition probabilities – continuous Markov process, and hidden Markov chain with applications.

Textbooks:

1. Gorden, S. P. and Gorden, F. S., *Contemporary Statistics, A Computer Approach*, McGraw-Hill, 1994.
2. Medhi, J., *Stochastic Processes*, Wiley Eastern, 1982.
3. Johnson, R. A., *Miller & Freund's Probability and Statistics for Engineers*, 6th ed., Prentice Hall, 2000.

References:

1. Levin, R. I. and Rubin, D. S., *Statistics for Management*, 7th ed., Prentice Hall, 1998.
2. Milton, J. S. and Arnold, J. C., *Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences*, McGraw-Hill, 2002.
3. Ross, S. M., *Introduction to Probability and Statistics for Engineers and Scientists*, 3rd ed., Academic Press, 2004.
4. Feller, W., *An Introduction to Probability Theory and Its Applications*, Vol. 1 & Vol. 2, John Wiley, 1968.

5. Hogg, R. V., Craig, T., and McKean, J. W., *Introduction to Mathematical Statistics*, 6th ed., Prentice Hall, 2004.
6. Hogg, R. V. and Tanis, E. A., *Probability and Statistical Inference*, 7th ed., Prentice Hall, 2005.
7. Larsen, R. J. and Marx, M. L., *An Introduction to Mathematical Statistics and Its Applications*, 4th ed., Prentice Hall, 2005.
8. Mendenhall, W., Wackerly, D., and Scheaffer, R. L., *Mathematical Statistics with Applications*, 7th ed., Duxbury Press, 2007.
9. Chung, K. L. and AitSahlia, F., *Elementary Probability Theory With Stochastic Processes and an Introduction to Mathematical Finance*, 4th ed., Springer, 2003.

AE221 AERODYNAMICS (3 – 1 – 0) 4 credits

Inviscid, incompressible flows – point vortex, vortex sheet – Biot–Savart law – airfoil nomenclature and characteristics – incompressible flow past airfoils – elements of panel method – flow over finite wings – calculation of lift and drag for aircraft – analysis of aerodynamic performance.

Textbook:

- Anderson Jr., , J. D., *Fundamentals of Aerodynamics*, 4th ed., McGraw-Hill, 2006.

References:

1. Bertin, J. J. and Smith, M. L., *Aerodynamics for Engineers*, 5th ed., Prentice Hall, 2008.
2. McCormick, B. W., *Aerodynamics, Aeronautics, and Flight Dynamics*, 2nd ed., John Wiley, 1995.
3. Kuethe, A. M. and Chow, C.-Y., *Foundations of Aerodynamics*, 5th ed., John Wiley, 1997.

AE222 HEAT TRANSFER (3 – 0 – 1) 4 credits

Introduction to heat transfer – steady state heat conduction (1-D, 2-D, 3-D) – transient heat conduction (lumped capacitance, 1-D, 3-D) – introduction to convective heat transfer – external forced convection – internal forced convection – natural/free convection – boiling and condensation – heat exchanger analysis and design – blackbody radiation and radiative properties – radiative exchange between surfaces.

Textbook:

- Incropera, F. P. and DeWitt, D. P., *Fundamentals of Heat and Mass Transfer*, 5th ed., John Wiley, 2002.

References:

1. Holman, J. P., *Heat Transfer*, 9th ed., Tata McGraw-Hill, 2007.
2. Çengel, Y. A., *Heat and Mass Transfer: A Practical Approach*, 3rd ed., Tata McGraw-Hill, 2006.

AE223 MECHANISMS AND MACHINE THEORY (3 – 1 – 0) 4 credits

Kinematics of machinery, definition – condition of constrained motion – inversion – velocity and acceleration diagrams of machines – instantaneous center – theory of cams – theory of gears and gear trains – static and dynamic force analysis of mechanisms – gyroscopes – balancing.

Textbook:

- Uicker, J. J., Pennock, G. R., and Shigley, J. E., *Theory of Machines and Mechanisms*, 3rd ed., Oxford Univ. Press, 2003.

References:

1. Rattan, S. S., *Theory of Machines*, 2nd ed., Tata McGraw-Hill, 2005.
2. Myszka, D. H., *Machines and Mechanisms: Applied Kinematics Analysis*, 3rd ed., Prentice Hall, 2004.

AE224 MANUFACTURING TECHNOLOGY I (3 – 0 – 0) 3 credits

Introduction, basic concepts and principles of manufacturing – metal casting technology – principles of solidification – various metal forming techniques and their analysis – joining processes like welding, brazing, and soldering – inspection – defects in manufacturing and their remedies.

Textbooks:

1. Ghosh, A. and Mallik, A. K., *Manufacturing Science*, 6th ed., Wiley Eastern, 2003.
2. Rao, P. N., *Manufacturing Technology: Foundry, Forming and Welding*, 2nd ed., Tata McGraw-Hill, 2007.
3. Dieter, G. E., *Mechanical Metallurgy*, 3rd ed., McGraw-Hill, 1988.

References:

1. Campbell, J. S., *Principles of Manufacturing Materials and Processes*, Tata McGraw-Hill, 1995.
2. Degarmo, E. P., Black, J. T., and Kohser, R. A., *Materials and Processes in Manufacturing*, 10th ed., Prentice Hall of India, 2007.
3. Linnert, G. E., *Welding Metallurgy*, AWS, 1994.

4. Heine, R. W., Loper, C. R., and Rosenthal, P. C., *Principles of Metal Casting*, 2nd ed., Tata McGraw-Hill, 1976.

CH221 ENVIRONMENTAL SCIENCE AND ENGINEERING (2 – 0 – 0) 2 credits

Awareness of the impact of environment on quality of life – natural resources – biological systems – bio-geo chemical cycles – chemical processes; water treatment operations, water sampling, storage, quality measurement – oxygen demand – detection of pollutants – current environmental issues; pollutants, global warming, causes and consequences, air pollution, organic and inorganic air pollutants, smog-acid mine drainage, accumulation of salts in water – soil formation; micro and macro nutrients in soil, pollutants in soil – green chemistry: an alternative tool for reducing pollution – engineering interventions; flow sheets, waste minimization, e-waste management, ASP, reverse osmosis, trickling filter – environmental management; solid, liquid waste management, hazardous wastes, ISO standards – Kyoto protocol, Montreal protocol, Euro norms.

Textbook:

- Rao, V., *Textbook of Environmental Engineering*, Prentice Hall of India, 2002.

References:

1. Baird, C. and Cann, M., *Environmental Chemistry*, 3rd ed., W. H. Freeman and Company, 2005.
2. *Manual on Water Supply and Treatment*, CPHEEO, Ministry of Urban Development, GOI, 1999.
3. *Manual on Sewerage and Sewage Development*, CPHEEO, Ministry of Urban Development, GOI, 1993.
4. Hauser, B. A., *Practical Hydraulics Hand Book*, Lewis Publishers, 1991.
5. Hammer, M. J., *Water and Wastewater Technology*, Regents/Prentice Hall, 1991.
6. Sharma, J. P., *Comprehensive Environmental Studies*, Laxmi Publications, 2004.
7. Garg, S. K., *Environmental Engineering* (Vol. 1 & Vol. 2), Khanna Publishers, 2004.
8. Kiely, G., *Environmental Engineering*, McGraw-Hill, 1997.
9. Bharucha, E., *Textbook of Environmental Studies*, University Grants Commission, 2004.
10. Vanloon, G. W. and Duffy, S. J., *Environmental Chemistry: A Global Perspective*, Oxford Univ. Press, 2000.

AE241 THERMAL AND FLUID LAB (0 – 0 – 3) 1 credit

SEMESTER V

MA311 MATHEMATICS V (3 – 0 – 0) 3 credits

Partial Differential Equations: introduction to PDE – modeling problems related and general second order PDE – classification of PDE, hyperbolic, elliptic and parabolic PDE – canonical form – scalar first order partial differential equations – method of characteristics – Charpits method – quasi-linear first order equations – shocks and rarefactions – solution of heat, wave, and Laplace equations using separable variable techniques and Fourier series.

Numerical Methods: solution of algebraic and transcendental equations – solution of system of linear equations – numerical integration – interpolation and curve fitting – solution of ordinary differential equations – approximation of functions.

Textbook:

- Kreyszig, E., *Advanced Engineering Mathematics*, 9th ed., John Wiley, 2005.

References:

1. Jain, M. K., Iyengar, S. R. K., and Jain, R. K., *Numerical Methods for Scientific and Engineering Computation*, New Age International Publishers, 2003.
2. Sneddon, I. N., *Elements of Partial Differential Equations*, McGraw-Hill, 1986.
3. Renardy, M. and Rogers, R. C., *An Introduction to Partial Differential Equations*, 2nd ed., Springer-Verlag, 2004.
4. Greenberg, M. D., *Advanced Engineering Mathematics*, Pearson Education, 2007.
5. McOwen, R. C., *Partial Differential Equations: Methods and Applications*, 2nd ed., Pearson Education, 2003.

AE311 GAS DYNAMICS (3 – 0 – 0) 3 credits

Governing equations – static and stagnation properties – speed of sound and Mach number – isentropic flow through variable area ducts – normal and oblique shocks – Fanno flow – Rayleigh flow – Prandtl–Meyer flow – small perturbations theory – unsteady wave motion.

Textbook:

- Anderson, J. D., *Modern Compressible Flow with Historical Perspective*, 3rd ed., McGraw-Hill, 2004.

References:

1. Zucker, R. D. and Biblarz, O., *Fundamentals of Gas Dynamics*, 2nd ed., John Wiley, 2002.
2. John, J. E. A. and Keith, T., *Gas Dynamics*, 3rd ed., Prentice Hall, 2006.

3. Yahya, S. M., *Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion*, 3rd ed., New Age International Publishers, 2003.

AE312 AEROSPACE STRUCTURES (3 – 0 – 0) 3 credits

Description of essential features of aircraft, rocket and spacecraft structures – introduction to theory of elasticity – linear and nonlinear strain descriptions – stress-strain relations – thermal stresses – isotropic and orthotropic materials – introduction to laminated composites – stress functions – torsion of solid sections – theory of thin plates and axisymmetric shells – structural instability – virtual work, energy and matrix methods – introduction to finite element method.

Textbook:

- Megson, T. H. G., *Aircraft Structures for Engineering Students*, 4th ed., Butterworth-Heinemann, 2007.

References:

1. Timoshenko, S. P. and Goodier, J. N., *Theory of Elasticity*, 3rd ed., McGraw-Hill, 1970.
2. Timoshenko, S. P. and Woinowsky-Krieger, S., *Theory of Plates and Shells*, 2nd ed., McGraw-Hill, 1964.
3. Osgood, C. C., *Spacecraft Structures*, Prentice Hall, 1966.

AE313 METROLOGY AND COMPUTER AIDED INSPECTION (3 – 0 – 0) 3 credits

Introduction to metrology, fundamentals of dimensional measurements, length standards, application of light interference for precision measurements – fits and tolerances – concepts and practices of gauging – comparators and their applications – linear and angular measurements – thread and gear inspection – form, flatness, straightness, and alignment measurements – surface metrology – co-ordinate metrology – laser applications in metrology – vision inspection – micro and nano metrology.

Textbooks:

1. Shotbolt, C. S. and Galyer. J., *Metrology for Engineers*, 5th ed., Cassell Publ., 1990.
2. Jain, R. K., *Engineering Metrology*, Khanna Pub., 2008. Busch, T., Fundamentals of Dimensional Metrology, Delmar Pub., 1988.

References:

1. Smith, G. T., *Industrial Metrology: Surfaces and Roundness*, Springer-Verlag, 2002.
2. Whitehouse, D. J., *Handbook of Surface Metrology*, Taylor & Francis, 1994.

AV316 INSTRUMENTATION AND CONTROL SYSTEMS (3 – 0 – 0) 3 credits

Instrumentation: sensitivity, linearity, and resolution of instruments – uncertainty of measurements – signal conditioners - bridge circuits, amplifiers, and filters – measurement of displacement, velocity, acceleration, force, torque, pressure, flow, temperature, and level.

Control Systems: classification of control systems – block diagram representation and reductions – mathematical background and mathematical model of physical systems – time domain analysis, transient response, and stability – frequency response methods, polar plot, bode diagrams, Nyquist stability criteria.

Controllers: types of controllers – types of control action; proportional, integral, derivative, on-off controls – hydraulic, electronic, and pneumatic controllers.

Textbooks:

1. Doebelin, E. O., *Measurement Systems: Application and Design*, 5th ed., McGraw-Hill, 2003.
2. Nise, N. S., *Control Systems Engineering*, 4th ed., Wiley India, 2003.

References:

1. Beckwith, T. G., Lewis Buck, N., and Marangoni, R. D., *Mechanical Measurements*, 3rd ed., Addison-Wesley, 1982.
2. Holman, J. P., *Experimental Methods for Engineers*, 7th ed., Tata McGraw-Hill, 2004.
3. Raman, R., *Principles of Mechanical Measurements*, Oxford & IBH, 1997.
4. D'Azzo, H., *Feedback Control System Analaysis and Synthesis*, CRC Press, 2007.
5. Mutambara, A. G. O., *Design and Analysis of Control Systems*, CRC Press, 2008.
6. Qiu, L. and Zhou, K., *Introduction to Feedback Control*, Prentice Hall, 2009.

HS311 INTRODUCTION TO SOCIAL SCIENCE AND ETHICS (2 – 0 – 0) 2 credits

Social science: introduction to sociology, anthropology – social science research design and sampling.

Ethics: professional and personal ethics – values and norms and human rights.

Textbook:

- Lecture Notes

References:

1. Perry, J. and Perry, E., *Contemporary Society: An Introduction to Social Science*, 11th ed., Allyn & Bacon, 2005.
2. Giddens, A., *Sociology*, 5th ed., Wiley, 2006.

3. Flyvbjerg, B., *Making Social Science Matter*, Cambridge Univ. Press, 2001.
4. Singer, P., *A Companion to Ethics*, Wiley-Blackwell, 1993.

AE331	MODELING AND ANALYSIS LAB	(0 – 0 – 3) 1 credit

AV335	INSTRUMENTATION AND CONTROL SYSTEMS LAB	(0 – 0 – 3) 1 credit

AV335	INSTRUMENTATION AND CONTROL SYSTEMS LAB	(0 – 0 – 3) 1 credit

SEMESTER VI

AE321 FLIGHT MECHANICS (3 – 0 – 0) 3 credits

Overview of aerodynamics, propulsion, atmosphere and aircraft instrumentation – frames of reference – body axis, wind axis, earth centric, inertial – equations of motion in non-rotating earth and flat-earth frames of reference – aircraft performance – gliding, cruise and climbing flight, optimal cruise trajectories, take-off and landing – V-n diagrams – static longitudinal, directional, and lateral stability and control – stick fixed and stick free stability, hinge moments, trim-tabs, aerodynamic balancing – effect of manoeuvres – aerodynamic modelling, simulation, concept of steady states, linearisation, decoupling of longitudinal and lateral/directional motion – dynamic stability, longitudinal motion and short period and phugoid modes, lateral/directional motion, spiral, divergence, roll subsidence and dutch roll modes – stability, control and performance characteristics of sounding rockets and launch vehicles.

Textbooks:

1. Hull, D. G., *Fundamentals of Airplane Flight Mechanics*, Springer, 2007.
2. Perkins, C. D. And Hage, R. E., *Airplane Performance Stability & Control*, John Wiley, 1949.

References:

1. Etkin, B., *Dynamics of Flight*, John Wiley, 1989.
2. McCormick, B. W., *Aerodynamics, Aeronautics, and Flight Dynamics*, 2nd ed., John Wiley, 1994.
3. Pamadi, B. N., *Performance, Stability, Dynamics, and Control of Airplanes*, 2nd ed., AIAA Edu. Series, 2004.
4. Smetana, F. O., *Flight Vehicle Performance and Aerodynamic Control*, AIAA Edu. Series, 2001.

AE322 SPACEFLIGHT MECHANICS (3 – 0 – 0) 3 credits

Dynamics of particle: reference frames and rotations, energy, angular momentum – two body motion: equations of motion, Kepler's laws, solution to two-body problem, conics and relations, vis-viva equation, Kepler equation, orbital elements, orbit determination, Lambert problem, satellite tracking – earth satellite operations: orbit maneuvers, Hohmann transfer, inclination change maneuvers, combined maneuvers, bi-elliptic maneuvers, effects due to atmospheric drag, earth oblateness effects, orbit maintenance – rocket performance: rocket equation, multi-staging – rigid body dynamics, satellite attitude dynamics, attitude control of spinning and non-spinning spacecrafts, re-entry trajectories, aerobraking – interplanetary trajectories: n-body problem, sphere of influence, synodic period, launch opportunity, methods of trajectory design, restricted three-body problem, Lagrangian points.

Textbooks:

1. Wiesel, W. E., *Spaceflight Dynamics*, 2nd ed., McGraw-Hill, 1996.
2. Tewari, A., *Atmospheric and Space Flight Dynamics: Modeling and Simulation with MATLAB and Simulink*, Birkhuser, 2007.

References:

1. Hale, F. J., *Introduction to Space Flight*, Prentice Hall, 1994.
2. Cornelisse, J. W., Schoyer, H. F. R., and Wakker, K. F., *Rocket Propulsion and Spaceflight Dynamics*, Pitman Publishing, 1979.

AE323 AIR-BREATHING PROPULSION (3 – 0 – 0) 3 credits

Review of combustion and flames – introduction to air breathing propulsion systems – review of basic gas dynamics equations – types of nozzles – design and operating characteristics – aircraft engine types – performance measures – fundamentals of aircraft gas turbine engine cycles – engine components and configurations – working performance evaluation – design and off design performance – basics of turbomachinery– compressor and turbine blade flow path analysis (centrifugal and axial types) – hypersonic air breathing engines – ramjet and scramjet – combustion systems.

Textbooks:

1. Hill, P. G. and Peterson, C. R., *Mechanics and Thermodynamics of Propulsion*, 2nd ed., Addison-Wesley, 1992.
2. Mattingly, J. D., *Elements of Propulsion: Gas Turbines and Rockets*, AIAA Edu. Series, 2006.

References:

1. Flack, R. D., *Fundamentals of Jet Propulsion with Applications*, Cambridge Univ. Press, 2005.
2. Mattingly, J. D., *Elements of Gas Turbine Propulsion*, AIAA Edu. Series, 2005.
3. Heiser, W. H. and Pratt, D. T., *Hypersonic Air Breathing Propulsion*, AIAA Edu. Series, 1994.

AE324 MANUFACTURING TECHNOLOGY II (3 – 0 – 0) 3 credits

Principles of metal cutting – mechanics of metal cutting – cutting tools – cutting processes – process variables – tool life.

Abrasive machining processes: grinding and fine finishing processes.

Machine tools: conventional machine tool configuration – CNC technology – CNC machine tools and programming.

Nontraditional machining: principles, equipment, process variables and applications – surface engineering – concept of CIM and FMS – additive manufacturing – advanced manufacturing technologies.

Textbooks:

1. Groover, M. P., *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*, Wiley India, 2007.
2. Kalpakjian, S. and Schmidt, S. R., *Manufacturing Engineering and Technology*, Pearson Education, 2009.

References:

1. Pandey, P. C. and Shah, H. S., *Modern Machining Processes*, Tata McGraw-Hill, 1988.
2. Juneja, B. L., Sekhon, G. S., and Seth, N., *Fundamentals of Metal Cutting and Machine Tools*, New Age International, 2008.

E01 *STREAM ELECTIVE I* (3 – 0 – 0) 3 credits

HS321 PRINCIPLES OF MANAGEMENT SYSTEMS (3 – 0 – 0) 3 credits

Personnel Management: introduction – changing role of personnel manager – new people management – manpower planning – recruitment and selection – performance appraisal – workers participation in management – grievance handling.

Industrial Management: management functions – organization – principles of planning – management by objectives – organization structures – principles of organizing – span of control – delegation, leadership, directing, and controlling.

Project Management: development of project network – project representation – project scheduling – linear time-cost trade-offs in projects: a heuristic approach – project monitoring and control with PERT.

References:

1. Koontz H., ODonnel, C., and Weihrich, H., *Essentials of Management*, McGraw-Hill, 1990.
2. Venkataratnam, C. S. and Srivastava, B. K., *Personnel Management and Human Resources*, Tata McGraw-Hill, 1991.
3. Mazda F., *Engineering Management*, Prentice Hall, 1997.
4. Gido, J. and Clements, J. P., *Successful Project Management*, 2nd ed., South-Western College Publishing, 2003.

5. Khanna, O. P., *Industrial Engineering and Management*, Dhanpat Rai Publications (P) Ltd., 2003.
6. Memoria, C. B. and Gankar, S. V., *Personnel Management – Text and Cases*, Himalaya Publishing House, 2007.

AE341	AERODYNAMICS AND FLIGHT MECHANICS LAB	(0 – 0 – 3) 1 credit

AE342	MANUFACTURING PROCESSES LAB	(0 – 0 – 3) 1 credit

SEMESTER VII

AE411 ROCKET PROPULSION (3 – 0 – 0) 3 credits

Introduction to rocket propulsion systems – rocket propulsion engines – types of rocket nozzles and thrust vector control – propellants – combustion in rocket engines – parameters for chemical rockets – elements of liquid propulsion systems – thrust chambers – turbo pumps – nonconventional propulsion techniques – solid rocket motors – grain configuration – hybrid rockets – rocket testing and performance evaluation – selection of rocket motors.

Textbook:

- Sutton, G. P. and Biblarz, O., *Rocket Propulsion Elements*, 7th ed., John Wiley, 2000.

References:

1. Hill, P. G. and Peterson, C. R., *Mechanics and Thermodynamics of Propulsion*, 2nd ed., Addison-Wesley, 1992.

AE412 AEROSPACE VEHICLE DESIGN (3 – 0 – 0) 3 credits

Aircraft Design: introduction – weight estimation – airfoil and geometry selection – thrust to weight ratio and wing loading – initial sizing – propulsion – landing gear and subsystems – aerodynamics – stability, control, and handling qualities – flight mechanics and performance issues.

Space Vehicle Design: mission design – basic orbital mechanics – range safety – rocket propulsion options – attitude determination and control – configuration and structural design – thermal control – power systems – design for re-entry – vehicle integration and recovery – introduction to multi-disciplinary design optimization.

Textbooks:

1. Raymer, D. P., *Aircraft Design: A Conceptual Approach*, 4th ed., AIAA Edu. Series, 2006.
2. Griffin, M. D. and French, J. R., *Space Vehicle Design*, 2nd ed., AIAA Edu. Series, 2004.

References:

1. Anderson, J. D., *Aircraft Design*, McGraw-Hill, 1999.
2. Corke, T. C., *Design of Aircraft*, Prentice Hall, 2002.
3. Fielding, J. P., *Introduction to Aircraft Design*, Cambridge Univ. Press, 1999.

E02 *STREAM ELECTIVE II* (3 – 0 – 0) 3 credits

E03	*STREAM ELECTIVE III*	(3 – 0 – 0) 3 credits
E04	*DEPARTMENT ELECTIVE*	(3 – 0 – 0) 3 credits
E05	*INSTITUTE ELECTIVE*	(3 – 0 – 0) 3 credits
AE431	AEROSPACE STRUCTURES LAB	(0 – 0 – 3) 1 credit
AE432	METROLOGY LAB	(0 – 0 – 3) 1 credit
AE451	SUMMER INTERNSHIP AND TRAINING	3 credits
AE452	SEMINAR	2 credits

SEMESTER VIII

AE453	COMPREHENSIVE VIVA-VOCE	3 credits
AE454	PROJECT WORK	12 credits

ELECTIVES

AE461 ADVANCED AERODYNAMICS (3 – 0 – 0) 3 credits

Introduction to experimental aerodynamic facilities – classification of experimental facilities – continuous, blow-down and impulse facilities – wind tunnel instrumentation – special testing techniques.

Introduction to computational aerodynamics – various levels of approximations – grid generation – boundary conditions.

Introduction to hypersonic flows – analytical and computational methods – hypersonic boundary layer theory – aerodynamic heating – viscous-inviscid interactions.

Re-entry vehicle aerodynamics – earth and Martian atmosphere models – continuum and free molecular flows.

Introduction to aerothermodynamics – real and perfect gases – chemical equilibrium and non-equilibrium – solutions for stagnation point flow.

Introduction to kinetic theory of gases – introduction to turbulence – use of turbulent models for external flows.

Textbooks:

1. Anderson Jr, J. D., *Hypersonic and High-Temperature Gas Dynamics*, 2nd ed., AIAA Edu. Series, 2006.
2. Barlow, J. B., Rae Jr, W. H., and Pope, A., *Low-Speed Wind Tunnel Testing*, 3rd ed., Wiley, 1999.
3. Versteeg, H. K., Malalasekera, W., *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*, 2nd ed., Prentice Hall, 2007.

References:

1. Pope, A. and Goin K. L., *High-Speed Wind Tunnel Testing*, Krieger Pub. Co., 1978.
2. Goethert, B. H., *Transonic Wind Tunnel Testing*, Dover, 2007.
3. Hirschel, E. H. and Weiland, C., *Selected Aerothermodynamic Design Problems of Hypersonic Flight Vehicles*, AIAA/Springer, 2009.
4. Toro, E. F., *Riemann Solvers and Numerical Methods for Fluid Dynamics: A Practical Introduction*, 2nd ed., Springer-Verlag, 1999.

AE462 ADVANCED AEROSPACE STRUCTURES (3 – 0 – 0) 3 credits

Description of essential features of aircraft, rocket and spacecraft structures – type of loads on flight structures – bending, shear and torsion of open and closed thin-walled beams – monocoque, stiffened plate, isogrid and sandwich constructions – idealization and stress analysis of typical aerospace structural components – pressurized structures – stress discontinuities – effects of cut-outs – effects of boundary conditions in open and closed section beams – structural fatigue.

Textbook:

- Megson, T. H. G., *Aircraft Structures for Engineering Students*, 4th ed., Butterworth-Heinemann, 2007.

References:

1. Timoshenko, S. P. and Goodier, J. N., *Theory of Elasticity*, 3rd ed., McGraw-Hill, 1970.
2. Timoshenko, S. P. and Woinowsky-Krieger, S., *Theory of Plates and Shells*, 2nd ed., McGraw-Hill, 1964.
3. Bruhn, E. F., *Analysis and Design of Flight Vehicle Structures*, 2nd ed., Jacobs Publishing Inc., 1973.

AE463 ADVANCED FLUID MECHANICS (3 – 0 – 0) 3 credits

Fluid kinematics – physical conservation laws – review of integral and differential formulations – Navier–Stokes and energy equations – solution of Navier–Stokes equations; steady and unsteady flows – waves in fluids (potential flow formulation) – boundary layer theory; Blasius solution, Falkner–Skan solutions, momentum integral approach – introduction to turbulent flows.

References:

1. White, F. M., *Viscous Fluid Flow*, 3rd ed., McGraw-Hill, 2006.
2. Panton, R. L., *Incompressible Flow*, 3rd ed., John Wiley, 2005.
3. Kundu, P. K. and Cohen, I. M., *Fluid Mechanics*, 4th ed., Academic Press, 2007.
4. Leal, L. G., *Advanced Transport Phenomena*, Cambridge Univ. Press, 2007.
5. Schlichting, H. and Gersten, K., *Boundary Layer Theory*, 8th ed., McGraw-Hill, 2001.

AE464 ADVANCED HEAT TRANSFER (3 – 0 – 0) 3 credits

Radiation Heat Transfer: fundamentals – view factors – network method and enclosure analysis for gray – diffuse enclosures containing transparent media – engineering treatment of gas radiation.

Two Phase Flow: fundamentals – flow patterns – basic equations for homogeneous flow and the separated-flow model.

Boiling Heat Transfer: pool boiling – forced convective – cross flow – multicomponent boiling – correlations for boiling coefficient – critical heat flux.

Condensation: modes of condensation – film-wise condensation on vertical surfaces – horizontal tube systems – condensation in multicomponent systems.

Enhancement of Heat Transfer: active, passive, and compound techniques.

Textbooks:

1. Incroprera, F. P. and Dewitt, D. P., *Heat and Mass Transfer*, 5th ed., Wiley, 2002.
2. Hewitt, G. F., Shires, G. L., and Bott, T. R., *Process Heat Transfer*, CRC Press, 1994.

References:

1. Çengel, Y. A., *Heat and Mass Transfer*, 3rd ed., Tata McGraw-Hill, 2007.
2. Das, S. K., *Process Heat Transfer*, Narosa, 2006.
3. Sparrow, E. M. and Cess, R. D., *Radiation Heat Transfer*, CRC Press, 1978.

AE466 AEROELASTICITY (3 – 0 – 0) 3 credits

Fundamental aspects of structural dynamics – free vibration and modal representation of flexible structures – application to beam extension, shear, bending and torsion dynamics – static aeroelasticity – wind tunnel models – divergence and aileron reversal – Lifting surfaces: torsional divergence and load redistribution, aeroelastic tailoring – aeroelastic flutter – stability characteristics – Flutter analysis: wind tunnel models – flexible wings.

Textbook:

- Hodges, H., *Introduction to Structural Dynamics and Aeroelasticity*, Cambridge Univ. Press, 2002.

AE467 ANALYSIS AND DESIGN OF COMPOSITE STRUCTURES (3 – 0 – 0) 3 credits

Introduction – classification and applications of composites – fiber-reinforced composites – micro and macro-mechanical analysis – analysis of simple laminated composite structural elements – failure and fracture of composite lamina – bending and vibration of composite and sandwich structural elements – design of aerospace composite and sandwich structures.

Textbook:

- Jones, R. M., *Mechanics of Composite Materials*, 2nd ed., Taylor & Francis, 1999.

References:

1. Gibson, R. F., *Principles of Composite Materials Mechanics*, 2nd ed., McGraw-Hill, 1994.
2. Daniel, I. M. and Ishai, O., *Engineering Mechanics of Composite Materials*, 2nd ed., Oxford Univ. Press, 2005.
3. Hong, T. H. and Tsai, S. W., *Introduction to Composite Materials*, Technomic Pub. Co., 1980.
4. Vasiliev, V. V. and Morozov, E. V., *Advanced Mechanics of Composite Materials*, 3rd ed., Elsevier, 2007.

AE468 COMPUTATIONAL FLUID DYNAMICS (3 – 0 – 0) 3 credits

Mathematical models for fluid dynamics – classification of partial differential equations – discretization methods – finite difference formulation – numerical solution of elliptic equations – linear system of algebraic equations – numerical solution of parabolic equations – stability analysis – numerical solution of hyperbolic equations – Burgers equation – incompressible Navier-Stokes equations and their solution algorithms – finite volume method.

Textbook:

- Hirsch, C., *Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics*, Vol. I, 2nd ed., Butterworth-Heinemann, 2007.

References:

1. Tannehill, J. C., Anderson, D. A., and Pletcher, R. H., *Computational Fluid Mechanics and Heat Transfer*, 2nd ed., Taylor & Francis, 1997.
2. Hoffmann, K. A. and Chiang, S. T., *Computational Fluid Dynamics for Engineers*, 4th ed., Engineering Education Systems, 2000.
3. Anderson, J. D., *Computational Fluid Dynamics: The Basics with Applications*, McGraw-Hill, 1995.
4. Patankar, S. V., *Numerical Heat Transfer and Fluid Flow*, Hemisphere, 1980.
5. Ferziger, J. H. and Perić, M., *Computational Methods for Fluid Dynamics*, 3rd ed., Springer, 2002.

AE469 COMPUTER INTEGRATED MANUFACTURING (3 – 0 – 0) 3 credits

Manufacturing Systems: computer integrated manufacturing – computer aided design (CAD) and engineering (CAE) – computer aided manufacturing (CAM) and concurrent engineering.

NC, CNC and DNC; CNC Machines: general concepts, design features, drives and controls, programming – adaptive control – machining centres.

Shop Floor Automation: automated material handling – assembly and inspection – computer aided process planning (CAPP) – computer integrated production management system – group technology and cellular manufacturing – flexible manufacturing system – automatic storage/retrieval systems (AS/RS) – Just In Time (JIT) – lean manufacturing.

Textbook:

- Groover, M. P., *Automation, Production Systems and Computer Integrated Manufacturing*, 3rd ed., Prentice Hall of India, 2007.

References:

1. Kant Vajpayee, S., *Principles of Computer Integrated Manufacturing*, Prentice Hall of India, 1995.
2. Rehg, J. A. and Kraebber, H. W., *Computer Integrated Manufacturing*, 3rd ed., Pearson Prentice Hall, 2004.
3. Venkateswaran, N. and Alavudeen, A., *Computer Integrated Manufacturing*, Prentice Hall of India, 2008.
4. Groover, M. P. and Zimmers, E. W., *CAD/CAM: Computer-Aided Design and Manufacturing*, Prentice Hall of India, 1984.

AE470 DESIGN OF AEROSPACE STRUCTURES (3 – 0 – 0) 3 credits

Design considerations – codes and standards – aerospace materials and their properties – selection of materials – failure theories – design criteria – strength, stiffness, fatigue, damage tolerance – fail safe and safe life designs – design aspects typical aerospace structural constructions: monocoque, stiffened plate, isogrid, sandwich and laminated composites – weight control – design of pressurized systems – configuration, design calculations and checks applied to typical aerospace structures – structural connections and joints – fasteners – design project.

References:

1. Shigley, J. E., Mischke, C., and Budynas, R., *Mechanical Engineering Design*, 7th ed., McGraw-Hill, 2003.
2. Bruhn, E. F., *Analysis and Design of Flight Vehicle Structures*, 2nd ed., Jacobs Publishing Inc., 1973.
3. Niu, M. C.Y., *Airframe Structural Design*, 2nd ed., Hongkong Conmilit Press Ltd., 2002.
4. Harvey, J. F., *Theory and Design of Modern Pressure Vessels*, 2nd ed., Van Nostrand, 1974.

AE471 CONVECTION HEAT TRANSFER (3 – 0 – 0) 3 credits

Introduction transport properties for viscous, conducting fluids – kinematic properties – fundamental conservation equations; Navier-Stokes equations and energy equation – dimensionless parameters – solution of Newtonian viscous flows – laminar shear layers momentum, thermal – laminar heat transfer in ducts – incompressible turbulent mean flows – free convection flows – mass transfer coupled flows convection with phase change – convection in porous media.

Textbooks:

1. Bejan, A., *Convection Heat Transfer*, Wiley, 3rd ed., Wiley, 2004.
2. Burmeister, L. C., *Convective Heat Transfer*, 2nd ed., Wiley, 1993.

AE472 EXPERIMENTAL AERODYNAMICS (3 – 0 – 0) 3 credits

Introduction to aerodynamic test facilities in various Mach number regimes: low speed, transonic, supersonic, hypersonic, and high enthalpy – design of subsonic, transonic, and supersonic wind tunnels – wind tunnel calibration – low speed flow visualisation techniques – dynamic stability derivatives – design of hypersonic wind tunnels – design of shock tube / shock tunnels – calibration of various wind tunnels – Flow visualisation techniques: Schlieren, shadowgraph, interferometry – introduction to laser diagnostic techniques – RTD, thermocouples, thermography, etc. – force measurement techniques in shock tunnel – introduction to wind tunnel instrumentation – Measurements techniques in wind tunnels: forces and moments, pressure, velocity, temperature, aeroacoustic measurements – error analysis – Instrumentation / data acquisition: steady and unsteady, shock tunnel data acquisition – virtual instrumentation – PLCs – measurement of steady and unsteady pressure, velocity, temperature, turbulence intensity, hot-wire, skin friction, forces and moments – Model design and fabrication: RP, FRP, metal, actuators – calibration of force, pressure and acoustic sensors.

References:

1. Barlow, J. B., Rae Jr, W. H., and Pope, A., *Low-Speed Wind Tunnel Testing*, 3rd ed., Wiley, 1999.
2. Pope, A. and Goin K., *High-Speed Wind Tunnel Testing*, Krieger Pub. Co., 1972.
3. Goethert, B. H., *Transonic Wind Tunnel Testing*, Dover Publications, 2007.
4. Pavian H. C., *Experimental Aerodynamics*, Pitman Publishing, 1940.
5. Mueller, T. J., Allen, C. S., Blake, W. K., Dougherty, R. P., Lynch, D., Soderman, P. T., and Underbrink, J. R., *Aeroacoustic Measurements*, Springer, 2010.
6. Langley, S. P., *Experiments in Aerodynamics*, Nabu Press, 2010.

AE473 FINITE ELEMENT METHOD (3 – 0 – 0) 3 credits

Introduction – weighted residual methods – Galerkin's method – variational approach – Rayleigh-Ritz method – one-dimensional finite element analysis; types of elements, shape functions – heat transfer problems – numerical integration – applications to structural mechanics – fluid flow problems.

Textbook:

- Segerlind, L. J., *Applied Finite Element Analysis*, 2nd ed., John Wiley, 1984.

References:

1. Henwood, D. and Bonet, J., *Finite Elements – A Gentle Introduction*, Macmillan, 1996.
2. Reddy, J. N., *Introduction to the Finite Element Method*, 3rd ed., McGraw-Hill, 2006.
3. Zienkiewicz, O. C., Taylor, R. L., and Nithiarasu, P., *Finite Element Method for Fluid Dynamics*, 6th ed., Elsevier Butterworth-Heinemann, 2005.

AE474 FRACTURE MECHANICS (3 – 0 – 0) 3 credits

Introduction and history of fracture mechanics – linear elastic fracture mechanics; energy release rate, stress intensity factor (SIF), relation between SIF and energy release rate, anelastic deformation at the crack tip – crack growth and fracture mechanisms – elastic-plastic analysis through J-integral – finite element analysis of cracks – fracture toughness testing – fatigue failure.

Textbook:

- Prashant Kumar, *Elements of Fracture Mechanics*, Tata McGraw-Hill, 2009.

References:

1. Broek, D., *Elementary Engineering Fracture Mechanics*, 4th ed., Kluwer Academic, 1986.
2. Anderson, T. L., *Fracture Mechanics: Fundamentals and Applications*, 3rd ed., CRC Press, 2004.

AE475 ENGINEERING VIBRATION (3 – 0 – 0) 3 credits

Introduction to vibration – single degree of freedom systems: free, undamped, damped, and forced vibrations – two-degree of freedom systems: principal modes of vibration, undamped vibration, forced vibration, forced damped vibrations – vibration isolation – multi-degree Freedom systems: eigenvalue problem – orthogonality of mode shapes, modal analysis for free, damped, and forced vibration systems – approximate methods for fundamental frequency – introduction to transient vibrations and non-linear vibrations.

Textbook:

- Rao, S. S., *Mechanical Vibrations*, 4th ed., Pearson Education, 2004.

References:

1. Thomson, W. T. and Daleh, M. D., *Theory of Vibration with Applications*, 5th ed., Prentice Hall, 1997.
2. Rao, J. S. and Gupta, K., *Introductory Course on Theory and Practice of Mechanical Vibrations*, 2nd ed., New Age International, 1999.
3. Meirovitch, L., *Elements of Vibration Analysis*, 2nd ed., McGraw-Hill, 1986.
4. Seto W. W., *Schaum's Outline of Theory and Problems of Mechanical Vibrations*, McGraw-Hill, 1964.

AE476 INDUSTRIAL ENGINEERING (3 – 0 – 0) 3 credits

Introduction, production planning and control – product design – value analysis and value engineering – plant location and layout – equipment selection – maintenance planning – job, batch, and flow production methods – group technology – work study – time and motion study – work/job evaluation – inventory control – manufacturing planning – total quality management – Taguchi's quality engineering – network models.

Textbooks:

1. Narasimhan, S. L., McLeavey D. W., and Billington, P. J., *Production, Planning and Inventory Control*, Prentice Hall, 1977.
2. Riggs, J. L., *Production Systems: Planning, Analysis and Control*, 3rd ed., Wiley, 1981.

References:

1. Muhlemann, A., Oakland, J. O., and Lockyer, K., *Productions and Operations Management*, Macmillan, 1992.
2. Taha, H. A., *Operations Research: An Introduction*, Prentice Hall of India, 1997.
3. Sharma, J. K., *Operations Research*, Macmillan, 1997.

AE477 FUNDAMENTALS OF COMBUSTION (3 – 0 – 0) 3 credits

Combustion and thermochemistry – chemical kinetics and mechanisms – reacting flows-premixed flames – detonation and explosion – diffusion flames.

Textbook:

- Turns, S. R., *An Introduction to Combustion*, 2nd ed., McGraw-Hill, 2000.

References:

1. Glassman, I. and Yetter, R. A., *Combustion*, 4th ed., Elsevier, 2008.
2. Kuo, K. K., *Principles of Combustion*, 2nd ed., John Wiley, 2005.
3. Warnatz, J., Maas, U., and Dibble, R. W., *Combustion* 4th ed., Springer, 2006.
4. Law C. K., *Combustion Physics*, Cambridge Univ. Press, 2006.

AE478 SUPPLY CHAIN MANAGEMENT (3 – 0 – 0) 3 credits

Introduction and a strategic view of supply chains – evolution of supply chain management (SCM) – decision phases in a supply chain – enablers of supply chain performance – supply chain strategy and performance measures – achieving strategic fit – network design in the supply chain – supply chain drivers and obstacles – operations decisions in supply chains – forecasting, aggregate planning – inventory control in supply chain – sourcing decisions in supply chain – supplier selection – transportation in supply chain – routing and scheduling using savings matrix method – coordination in supply chain – bullwhip effect – enabling supply chain management through information technology.

Textbook:

- Chopra, S. and Meindl, P., *Supply Chain Management: Strategy, Planning, and Operation*, Pearson Prentice Hall of India, 2007.

References:

1. Levi, D. S., Kaminsky, P., Levi, E. S., and Shankar, R., *Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies*, Tata McGraw-Hill, 2008.
2. Stadtler, H. and Kilger, C., *Supply Chain Management and Advanced Planning: Concepts, Models, Software and Case Studies*, 3rd ed., Springer-Verlag, 2003.
3. Shapiro, J. F., *Modeling the Supply Chain*, Thomson Learning, 2007.
4. Vollmann, T. E., Berry, W. L., Whybark, D. C., and Jacobs, F. R., *Manufacturing Planning and Control for Supply Chain Management*, Tata McGraw-Hill, 2006.

AE479 INTRODUCTION TO OPTIMIZATION (3 – 0 – 0) 3 credits

Optimization in science and engineering – general and special classes of problems – characterization of unconstrained and constrained minima – Lagrange multipliers – KKT conditions – linear programming – simplex tableau – duality – one dimensional optimization – elimination and interpolation techniques – multidimensional unconstrained minimization – steepest descent – Newton's and quasi-Newton techniques – randomized searches – genetic algorithm and simulated annealing – introduction to constrained minimization – large scale problems – multi-disciplinary optimization – applications in design, analysis, and control.

Textbook:

- Deb, K., *Optimization for Engineering Design: Algorithms and Examples*, Prentice Hall of India, 2004.

References:

1. Rao, S. S., *Engineering Optimization: Theory and Practice*, Wiley Eastern, 1996.

AE480 NONTRADITIONAL MACHINING (3 – 0 – 0) 3 credits

Nontraditional machining – thermal, chemical, and abrasives techniques; need, principle, process mechanics and variables, equipments, performance characteristics – application and recent trends of electrical discharge machining (EDM), wire EDM, wire EDG, electro-chemical machining (ECM), ECG, ultrasonic, laser beam, electron beam, abrasive and water jet machining, and hybrid processes – nontraditional micromachining.

Textbooks:

1. Jain, V. K., *Advanced Machining Processes*, Allied Pub., 2002.
2. Mishra, P. K., *Nonconventional Machining*, Narosa, 2006.

References:

1. Sharma, P. C., *A Textbook of Production Engineering*, S. Chand & Co., 2005.
2. Benedict, G. F., *Non-Traditional Machining Processes*, Marcel Dekker, 1987.
3. Pandey, P. C. and Shan, H. S., *Modern Machining Process*, Tata McGraw-Hill, 2004.

AE483 ROBOT MECHANISMS AND MOTION PLANNING (3 – 0 – 0) 3 credits

Overview of robotics – different types of robots – manipulators and mobile robots – mechanisms used in robots – serial and parallel chains – degrees of freedom – means of mobility, rovers.

Rigid body displacements – homogenous transformation – mechanism parameters – Denavit–Hartenberg notation – forward and inverse kinematic problems – velocity and static analysis.

Higher level control – motion planning, obstacle avoidance – road map and potential field methods – higher level sensors – vision, laser and ultrasonic range finders – localization and mapping.

References:

1. Ghosal, A., *Robotics: Fundamental Concepts and Analysis*, Oxford Univ. Press, 2006.
2. Choset, H., Lynch, K. M., Hutchinson, S., Kantor, G., Burgard, W., Kavraki, L. E., and Thrun, S., *Principles of Robot Motion: Theory, Algorithms, and Implementations*, MIT Press, Prentice Hall of India, 2005.
3. Craig, J. J., *Introduction to Robotics: Mechanics and Control*, 2nd ed., Pearson Education, 2001.

AE484 SPACE MISSION DESIGN AND OPTIMIZATION (3 – 0 – 0) 3 credits

Launch vehicle ascent trajectory design – reentry trajectory design – low thrust trajectory design – satellite constellation design – rendezvous mission design – ballistic lunar and interplanetary trajectory design – basics of optimal control theory – mission design elements for various missions – space flight trajectory optimization – direct and indirect optimization techniques – restricted 3-body problem – Lagrangian points – mission design to Lagrangian point.

Textbooks:

1. Osborne, G. F. and Ball, K. J., *Space Vehicle Dynamics*, Oxford Univ. Press, 1967.
2. Hale, F. J., *Introduction to Space Flight*, Prentice Hall, 1994.
3. Naidu, D. S., *Optimal Control Systems*, CRC Press, 2003.

References:

1. Chobotov, V., *Orbital Mechanics*, AIAA Education Series, 2002.
2. Griffin, M. D. and French, J. R., *Space Vehicle Design*, 2nd ed., AIAA, 2004.
3. Newcomb, R. W. and Kirk, D. E., *Optimal Control Theory: An Introduction*, Prentice Hall, 1990.
4. Bulirsch, R., Miele, A., Stoer, J., and Well, K. H. (Ed.), *Optimal Control: Calculus of Variations, Optimal Control Theory and Numerical Methods*, Birkhauser Verlag, 1993.

AE486 REFRIGERATION AND CRYOGENICS (3 – 0 – 0) 3 credits

Refrigeration: introduction – analysis of VCR cycles – multistage, multi-evaporator, cascade systems – properties and selection of pure and mixed refrigerants – properties of binary mixtures – analysis of vapor absorption cycles – aqua ammonia and LiBr water cycles – air cycle refrigeration, vortex tube, thermoelectric refrigeration.

Cryogenic Engineering: historical background and applications – gas liquefaction systems – gas separation and gas purification systems – cryogenic refrigeration systems – storage and handling of cryogens – cryogenic insulations – liquefied natural – gas-properties of materials of low temperatures – material of construction and techniques of fabrication – instrumentation – ultra-low temperature techniques – application.

Textbooks:

1. Stoecker, W. F. and Jones, J. W., *Refrigeration & Air Conditioning*, Tata McGraw-Hill, 1986.
2. Barron, R. F., *Cryogenic Systems*, 2nd ed., Oxford Univ. Press, 1985.

References:

1. Gosney W. B, *Principles of Refrigeration*, Cambridge Univ. Press, 1982.
2. Weisend, J. G., *The Handbook of Cryogenic Engineering*, Taylor & Francis, 1998.

AE487 TURBOMACHINES (3 – 0 – 0) 3 credits

Classification – specific work – representation of specific work in T-s and h-s diagrams – Internal and external losses – Euler's equation of turbomachinery – ideal and actual velocity triangles – slip and its estimation – impulse and reaction type machines – degree of reaction – effect of outlet blade angle on blade shape – model laws, specific speed and shape number – special features of steam and gas turbines – performance characteristics of turbomachines – cavitation, surge and stall – thin aerofoil theory – cascade mechanics.

Textbook:

- Dixon, S. L., *Fluid Mechanics and Thermodynamics of Turbomachinery*, 5th ed., Butterworth-Heinemann, 2005.

References:

1. Baskharone, E. A., *Principles of Turbomachinery and in Air-Breathing Engines*, Cambridge Univ. Press, 2006.
2. Wright, T., *Fluid Machinery: Performance, Analysis, and Design*, CRC Press, 1999.

AE488 ADVANCED MANUFACTURING AND AUTOMATION (3 – 0 – 0) 3 credits

Precision Engineering: concepts, materials, processes – high speed machining; CNC machine tools and machining centres, adaptive systems, multi axis CNC programming – micro/nano scale manufacturing – recent development in nontraditional machining.

Automation: introduction to automated manufacturing, basic concepts, automated work piece handling, orientation, positioning – flexible automation – assembly automation, product design for automation – automated inspection – sensors and actuators for automation – PLC programming and applications in automation.

Textbooks:

1. Groover, M. P., *Automation, Production Systems, and Computer-Integrated Manufacturing*, 3rd ed., Prentice Hall, 2007.
2. Boothroyd, G., *Assembly Automation and Product Design*, 2nd ed., CRC Press, 2005.

AE489 AEROSPACE MATERIALS AND PROCESSES (3 – 0 – 0) 3 credits

Properties of materials: strength, hardness, fatigue, and creep – Ferrous alloys: stainless steels, maraging steel, aging treatments – Aluminum alloys: alloy designation and tempers, Al-Cu alloys, principles of age hardening, hardening mechanisms, Al-Li alloys, Al-Mg alloys, nanocrystalline aluminum alloys – Titanium alloys: α-β alloys, superplasticity, structural titanium alloys, intermetallics – Magnesium alloys: Mg-Al and Mg-Al-Zn alloys – Superalloys: processing and properties of superalloys, single-crystal superalloys, environmental degradation and protective coatings – Composites: metal matrix composites, polymer based composites, ceramic based composites, carbon carbon composites.

Textbooks:

1. Polmear, I. J., *Light Alloys: From Traditional Alloys to Nanocrystals*, 4$^{\text{th}}$ ed., Elsevier, 2005.
2. Reed, R. C., *The Superalloys: Fundamentals and Applications*, Cambridge Univ. Press, 2006.

References:

1. Cantor, B., Assender, H., and Grant, P. (Ed.), *Aerospace Materials*, CRC Press, 2001.
2. *ASM Speciality Handbook: Heat Resistant Materials*, ASM International, 1997.
3. Campbell, F. C., *Manufacturing Technology for Aerospace Structural Materials*, Elsevier, 2006.
4. Kainer, K. U. (Ed.), *Metal Matrix Composites*, Wiley-VCH, 2006.

AE490 HEAT TRANSFER IN SPACE APPLICATIONS (3 – 0 – 0) 3 credits

Space Craft Thermal Environments: launch and ascent environments – environment of earth orbit – environments of interplanetary missions.

Thermal Control Techniques: passive thermal control techniques: thermal coating materials, thermal insulation, heat sinks, phase change materials – Active thermal control techniques: electrical heaters, thermal louvers, HPR fluid systems, heat pipes, spaceborne cooling systems.

Insulation-Blanket Design: materials-attachment – high temperature blankets – insulation for in-atmosphere applications.

Phase change materials – when to use a PCM-PCM design.

Heat Pipes-Types-Analysis-Testing: heat pipe applications and performances.

Thermal Contact Resistance and Its Calculation: parameters influencing thermal joint resistance-effect of oxidation and interstitial effects.

Ablative Heat Transfer: physical process and calculation of ablation rates – hypersonic ablation of graphite – heat transfer at high velocities – heat transfer in rarefied gases-transpiration and film cooling.

Textbook:

- Gilmore, D. G., *Spacecraft Thermal Control Handbook, Volume I: Fundamental Technologies*, 2nd ed., The Aerospace Press, American Institute of Aeronautics and Astronautics, 2002.

References:

1. Fortescue, P., Swinerd, G., and Stark, J. (Ed.), *Spacecraft Systems Engineering*, 4th ed., John Wiley & Sons, 2011.
2. Mayer, R. X., *Elements of Space Technology for Aerospace Engineers*, Academic Press, 1999.
3. NASA SP 8105.

AE491 STRUCTURAL DYNAMICS (3 – 0 – 0) 3 credits

Review of vibration of SDOF systems – response to transient loading – response to general dynamic loading – multi degree of freedom systems – vibration of continuous systems; strings, rods, shafts, beams, and plates – natural modes of vibration; exact solutions and approximate methods – introduction to random vibrations.

Textbook:

- Meirovitch, L., *Elements of Vibration Analysis*, 2nd ed., Tata McGraw-Hill, 2006.

References:

1. Meirovitch, L., *Analytical Methods in Vibrations*, Macmillan, 1967.
2. Clough, R. W., and Penzien, J., *Dynamics of Structures*, 2nd ed., McGraw-Hill, 1993.
3. Craig, R. R., *Structural Dynamics: An Introduction to Computer Methods*, John Wiley, 1982.
4. Thomson, W. T. and Daleh, M. D., *Theory of Vibration with Applications*, 5th ed., Prentice Hall, 1997.

AE492 TOOL ENGINEERING AND DESIGN (3 – 0 – 0) 3 credits

Cutting Tool: materials, geometry and nomenclature – single point and multi point cutting tools – grinding wheels – effect of tool geometry on machining characteristics – tool wear – tool life and economics of machining.

Inserts: geometry, nomenclature and materials – design concepts – coatings – selection and applications of cutting tools and inserts – design of tool holders – boring, broaching, surface finishing operations.

Tooling for CNC Machining: work holding – modular and automated tool handling – tooling for micro machining – conventional micro tools and electrodes for EDM & ECM – mechanism of ductile cutting, nanometric cutting, and chip formation – job examples and case study.

Design of Jigs and Fixtures: standard work holding devices and clamping elements – fixtures for milling – jigs for drilling and reaming – fixtures for welding – indexing jigs – design and sketching of jigs and fixtures – simple job examples and case study.

References:

1. Spitler, D., Lantrip, J., Nee, J., and Smith, D. A., *Fundamentals of Tool Design*, 5th ed., Society of Manufacturing Engineers, 2003.
2. Donaldson, C., LeCain, G. H., and Goold, V. C., *Tool Design*, Tata McGraw-Hill, 1998.
3. Hoffman, E., *Jig and Fixture Design*, 5th ed., Delmar Thomson Learning, 2004.
4. *Hindustan Machine Tools, Production Technology*, Tata McGraw-Hill, 1986.
5. Bhattacharyya A., *Metal Cutting Theory and Practice*, New Central Book Agency, 2000.
6. Wilson F. W., *Hand Book of Fixture Design*, McGraw-Hill, 1962.
7. Benedict, G. F., *Non-Traditional Machining Processes*, Marcel Dekker Inc., 1987.
8. Mishra, P. K., *Nonconventional Machining*, Narosa, 2006.