ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

REGULATIONS 2013

M.E AEROSPACE TECHNOLOGY

I TO IV SEMESTERS CURRICULUM AND SYLLABUS (FULL TIME)

SEMESTER I

(Common to Launch Vehicle Technology & Satellite Technology streams)

SL.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AS7101	Aerospace Structural Mechanics	3	1	0	4
2.	AS7102 AS7103	Aerospace Engineering (For Non-Aero stream) Or Electronic Systems (For Aero Stream)	3	0	0	3
3.	AO7103	Aerospace Propulsion	3	1	0	4
4.	AS7104	Elements of Satellite Technology	3	0	0	3
5.	AS7105	Flight Instrumentation	3	0	0	3
6.	MA7170	Advanced Mathematical Methods	3	1	0	4
PRACTICAL						
7	AS7111	Aerodynamics Laboratory	0	0	4	2
8	AS7112	Aerospace Propulsion Laboratory	0	0	4	2
		TOTAL	**18**	**3**	**8**	**25**

SEMESTER II Launch Vehicle Technology (LVT)						
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
THEORY						
1	AS7201	Missile Guidance And Control	3	0	0	3
2	AO7202	Finite Element Methods	3	1	0	4
3	AS7202	Launch Vehicle Aerodynamics	3	0	0	3
4	AO7018	Rocketry and Space Mechanics	3	0	0	3
5		Elective I	3	0	0	3
6		Elective II	3	0	0	3
PRACTICALS						
7	AS7211	Structures Laboratory	0	0	4	2
		TOTAL	**18**	**1**	**4**	**21**

SEMESTER II Satellite Technology (ST)						
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
THEORY						
1	AS7203	Spacecraft Power Systems	3	0	0	3
2	AS7204	Spacecraft Navigation Systems	3	0	0	3
3	AS7205	Spacecraft Communication Systems	3	0	0	3
4	AO7018	Rocketry and Space Mechanics	3	0	0	3
5		Elective I	3	0	0	3
6		Elective II	3	0	0	3
PRACTICALS						
7	AS7212	Modeling and Simulation Lab	0	0	4	2
		TOTAL	**18**	**0**	**4**	**20**

SEMESTER III Launch Vehicle Technology (LVT)						
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
THEORY						
1	AS7301	Chemical Rocket Technology	3	0	0	3
2		Elective III	3	0	0	3
3		Elective IV	3	0	0	3
PRACTICALS						
4	AS7311	Project work Phase I	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER III Satellite Technology (ST)						
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
THEORY						
1	AS7302	Spacecraft Guidance and Control	3	0	0	3
2		Elective III	3	0	0	3
3		Elective IV	3	0	0	3
4	AS7311	Project work Phase I	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

Common to Launch Vehicle Technology & Satellite Technology streams

SEMESTER IV						
SL. NO.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
PRACTICAL						
1	AS7411	Project work Phase II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

Total number of credits: Launch Vehicle Technology = 73   Satellite Technology = 72

List of Electives for Launch Vehicle Technology Stream

SL. NO	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1.	AS7001	Aerospace Materials	3	0	0	3
2.	AS7002	Reliability and Quality Assurance	3	0	0	3
3.	AS7003	Systems Engineering	3	0	0	3
4.	AS7004	Testing and Instrumentation of Aerospace Systems	3	0	0	3
5.	AS7005	Space Weapons And Warfare	3	0	0	3
6.	AS7006	CFD for Aerospace Applications	3	0	0	3
7.	AO7204	Composite Materials and Structures	3	0	0	3
8.	AO7016	Advanced Propulsion Systems	3	0	0	3
9.	AO7015	Computational Heat Transfer	3	0	0	3
10.	AO7009	Fatigue And Fracture Mechanics	3	0	0	3
11.	AO7011	Hypersonic Aerodynamics	3	0	0	3
12.	AO7005	Structural Dynamics	3	0	0	3

List of Electives for Satellite Technology Stream

SL. NO	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1.	AS7001	Aerospace Materials	3	0	0	3
2.	AS7002	Reliability and Quality Assurance	3	0	0	3
3.	AS7003	Systems Engineering	3	0	0	3
4.	AS7004	Testing and Instrumentation of Aerospace Systems	3	0	0	3
5.	AS7007	Digital Image Processing For Aerospace Applications	3	0	0	3
6.	AS7008	Manned Space Missions	3	0	0	3
7.	AS7009	Mathematical Modeling and Simulation	3	0	0	3
8.	AS7201	Missile Guidance and Control	3	0	0	3
9.	AS7010	Digital Fly-By Wire Control	3	0	0	3
10.	AS7011	Fault Tolerant Computing	3	0	0	3
11.	AS7012	Soft Computing for Avionics Engineers	3	0	0	3
12.	AS7013	Electromagnetic Interference and Compatibility	3	0	0	3

AS7101 AEROSPACE STRUCTURAL MECHANICS **L T P C**
3 1 0 4

OUTCOME:
Upon completion of the course, Students will get knowledge on different types of beams and columns subjected to various types of loading and support conditions and analysis of missile structures.

UNIT I BENDING OF BEAMS 12
Elementary theory of bending – Introduction to semi-monocoque structures - Stresses in beams of symmetrical and unsymmetrical sections -Box beams – General formula for bending stresses-principal axes method – Neutral axis method.

UNIT II SHEAR FLOW IN OPEN SECTIONS 9
Shear stresses in beams – Shear flow in stiffened panels - Shear flow in thin walled open tubes – Shear centre – Shear flow in open sections with stiffeners.

UNIT III SHEAR FLOW IN CLOSED SECTIONS 15
Shear flow in closed sections with stiffeners– Angle of twist - Shear flow in two flange and three flange box beams – Shear centre - Shear flow in thin walled closed tubes - Bredt-Batho theory - Torsional shear flow in multi cell tubes - Flexural shear flow in multi cell stiffened structures.

UNIT IV STABILITY PROBLEMS 12
Stability problems of thin walled structures– Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham's and Gerard's methods–Sheet stiffener panels-Effective width, Inter rivet and sheet wrinkling failures-Tension field web beams(Wagner's).

UNIT V ANALYSIS OF AEROSPACE STRUCTURAL COMPONENTS 12
Missile structures- satellite – mini, micro structures.

L : 45, T : 15, TOTAL: 60 PERIODS

REFERENCES

1. E.F. Bruhn, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., 1980.
2. Megson, T.M.G; Aircraft Structures for Engineering Students, Edward Arnold, 1995.
3. Peery, D.J. and Azar, J.J., Aircraft Structures, 2nd Edition, McGraw-Hill, New York, 1993.
4. Stephen P. Tinnoshenko & S.woinowsky Krieger, Theory of Plates and Shells, 2nd Edition, McGraw-Hill, Singapore, 1990.
5. Rivello, R.M., Theory and Analysis of Flight structures, McGraw-Hill, N.Y., 1993.

AS7102 AEROSPACE ENGINEERING **L T P C**
3 0 0 3

OUTCOME:
Upon completion of this course, students can learn the basics of aerodynamics, structures, propulsion and flight mechanics.

UNIT I INTRODUCTION 8
How an Airplane flies - components of an airplane and their functions - Airfoils and streamlines - forces acting on an airplane - lift and drag – types of Drag– speed and power – International Standard Atmosphere.

UNIT II AIRCRAFT PERFORMANCE 8
Straight and level flight– conditions for minimum Drag and minimum power– climbing and gliding – Range and Endurance – Take off and Landing – V-n diagram.

UNIT III STABILITY AND CONTROL 9

Concepts of static and dynamic stability and control– yaw and sideslip – dihedral effect – rudder requirements – directional and spiral divergence – Dutch roll– autorotation and spin.

UNIT IV AERODYNAMICS & PROPULSION 12

Flow over various bodies – Centre of pressure and aerodynamics centre – Pressure distribution over airfoil and cylinder – Introduction to wind tunnels - Aircraft propulsion, Rocket propulsion, power plant classification, principles of operation, Areas of their application.

UNIT V AIRCRAFT STRUCTURES 8

Constructional details of wing, fuselage, empennage, landing gears – Different types of loads - Monocoque and Semi-monocoque structure - Types of materials for aircraft construction

TOTAL: 45 PERIODS

REFERENCES

1. Kermode, A.C, ‘Mechanics of Flight’ English Book Store, New Delhi, 1982.
2. Van Sickle Neil, D ‘Modern Airmanship’ VanNostrand Reinhol, New York, 1985.
3. Megson T.H. ‘Aircraft Structures for Engineering Student’s II Edition, Edward Arnold, Kent, U.S.A. 1990

AS7103 ELECTRONIC SYSTEMS

L	T	P	C
3	0	0	3

OUTCOME:

Upon completion of the course, the Students will understand the available basic concepts of Electronic Systems to the engineers and the necessary basic understanding of electronic systems, their design and operation.The students will also have an exposure on various topics such as Operational Amplifiers, Digital Systems, Microprocessor and Microcontroller based systems and will be able to deploy these skills effectively in understanding the systems and analyzing the electronic systems employed in avionics engineering.

UNIT I LINEAR IC’s 9

OP-AMP specifications, applications, voltage comparator, A/D and D/A converter, sample and hold circuit, timer, VCO, PLL, interfacing circuits.

UNIT II DIGITAL SYSTEMS 9

Review of TTL, ECL, CMOS- Logic gates, Flip Flops, Shift Register, Counter, Multiplexer, Demultiplexer / Decoder, Encoder, Adder, Arithmetic functions, analysis and design of clocked sequential circuits, Asynchronous sequential circuits.

UNIT III SIGNAL GENERATORS 9

Monostable, Astable and Bistable mutivibrators.Schmitt Trigger. Conditions for oscillation, RC phase shift oscillator, Wien bridge oscillator, Crystal oscillator. LC oscillators. Relaxation oscillators

UNIT IV MICROCONTROLLER BASED SYSTEMS 12

8031 / 8051 Micro controllers:– Architecture- Assembly language Programming -Timer and Counter Programming- External Memory interfacing - Introduction to 16 bit Microcontrollers - Peripheral Interfacing - 8255 PPI, 8259 PIC, 8251 USART, 8279 Keyboard display controller and 8253 Timer/ Counter – Interfacing with 8085 - A/D and D/A converter interfacing.

UNIT V VIRTUAL INSTRUMENTATION 6

Definition and Flexibility – Block diagram and Architecture of Virtual Instruments – Virtual Instruments versus Traditional Instruments – Review of software in Virtual Instrumentation – VI programming techniques.

TOTAL: 45 PERIODS

REFERENCES:

1. Jacob Millman, Christos C Halkias, Satyabrata Jit, Millman's, "Electronic Devices and Circuits", Second Edition, Tata McGraw Hill,New Delhi, 2007.
2. Donald P Leach, Albert Paul Malvino, Goutam Saha, "Digital Principles and Applications", 6th Edition Tata McGraw Hill, New Delhi,2006..
3. Gayakwad, Ramakant A., "Op-Amps And Linear Integrated Circuits", Prentice Hall/ Pearson Higher Education, New Delhi, 1999.
4. Ayala, K.J., "The 8051 Microcontroller Architecture and Programming Applications", Penram International Publishing (India) Pvt. Ltd, 2004.
5. Bitter, R., Mohiuddin, T. and Nawrocki, M., "Labview Advanced Programming Techniques", CRC Press, 2nd Edition, 2007.

AO7103 AEROSPACE PROPULSION L T P C
3 1 0 4

OUTCOME:

Upon completion of the course, students will learn the principles of operation and design of aircraft and spacecraft power plants.

UNIT I ELEMENTS OF AIRCRAFT PROPULSION 12

Classification of power plants - Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption - Thrust and power- Factors affecting thrust and power- Illustration of working of Gas turbine engine - Characteristics of turboprop, turbofan and turbojet , Ram jet, Scram jet – Methods of Thrust augmentation.

UNIT II PROPELLER THEORY 12

Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts.

UNIT III INLETS, NOZZLES AND COMBUSTION CHAMBERS 12

Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio – Starting problem in supersonic inlets –Modes of inlet operation, jet nozzle – Efficiencies – Over expanded, under and optimum expansion in nozzles – Thrust reversal. Classification of Combustion chambers - Combustion chamber performance – Flame tube cooling – Flame stabilization.

UNIT IV AXIAL FLOW COMPRESSORS, FANS AND TURBINES 12

Introduction to centrifugal compressors- Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction – radial equilibrium theory- performance maps- axial flow turbines- geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

UNIT V ROCKET AND ELECTRIC PROPULSION 12

Introduction to rocket propulsion – Reaction principle – Thrust equation – Classification of rockets based on propellants used – solid, liquid and hybrid – Comparison of these engines with special reference to rocket performance – electric propulsion – classification- electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters.

TOTAL : 60 PERIODS

REFERENCES

1. Hill,P.G. and Peterson, C.R. Mechanics and Thermodynamics of Propulsion, Addison – Wesley Longman Inc. 1999
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo,H.I.H, Gas Turbine Theory, Longman,1989
3. G.C. Oates, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985.
4. G.P.Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1986.
5. W.P.Gill, H.J.Smith & J.E. Ziurys, "Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co., 1980.

AS7104	ELEMENTS OF SATELLITE TECHNOLOGY	L T P C
		3 0 0 3

OUTCOME:

Upon completion of the course, students can acquire knowledge about satellite orbit control and telemetry systems.

UNIT I SATELLITE MISSION AND CONFIGURATION 9

Mission Overview – Requirements for different missions – Space Environment, Spacecraft configuration- Spacecraft Bus – Payload – Requirements and constraints – Initial configuration decisions and Trade-offs – Spacecraft configuration process – Broad design of Spacecraft Bus – Subsystem layout – Types of Satellites – Constellations – Applications

UNIT II POWER SYSTEM 8

Power sources – Energy storage – Solar panels – Deployable solar panels – Spacecraft Power management – Power distribution – Deep Space Probes

UNIT III ATTITUDE AND ORBIT CONTROL SYSTEM (AOCS) 9

Coordinate system – AOCS requirements – Environment effects – Attitude stabilization – Attitude sensors – Actuators – Design of control algorithms.

UNIT IV PROPULSION SYSTEMS, STRUCTURES AND THERMAL CONTROL 11

Systems Trade-off – Mono-propellant systems – Thermal consideration – System integration design factors – Pre-flight test requirements – System reliability Configuration design of Spacecraft structure – Structural elements – Material selection – Environmental Loads -Vibrations – Structural fabrication – Orbital environments - Average temperature in Space – Transient temperature evaluation – Thermal control techniques – Temperature calculation for a spacecraft – Thermal design and analysis program structure – Thermal design verification – Active thermal control techniques.

UNIT V TELEMETRY SYSTEMS 8

Base Band Telemetry system – Modulation – TT & C RF system – Telecommand system – Ground Control Systems

L : 45, T :15 TOTAL: 45 PERIODS

REFERENCES:
1. Space Mission Analysis and Design (Third Edition) by James R.Wertz and Wiley J.Larson – 1999.
2. James R.Wertz "Spacecraft Attitude Determination and Control", Kluwer Academic Publisher, 1988.
3. Marcel J.Sidi "Spacecraft Dynamics and Control", Cambridge University press, 1997.
4. Lecture notes on " Satellite Architecture", ISRO Satellite Centre Bangalore – 560 017

AS7105	**FLIGHT INSTRUMENTATION**	**L T P C**
		3 0 0 3

OUTCOME:
Upon completion of the course, the students will understand the available basic concepts of Flight instruments to the engineers and the necessary knowledge that are needed in understanding their significance and operation. The students will also have an exposure to various topics such as measurement concepts, air data sensors and measurements, Flight Management Systems, and other instruments pertaining to Gyroscopic measurements and Engine data measurements and will be able to deploy these skills effectively in understanding and analyzing the instrumentation methods in avionics engineering.

UNIT I MEASUREMENT SCIENCE AND DISPLAYS 9
Instrumentation brief review-Concept of measurement-Errors and error estimation- Functional elements of an instrument system –Transducers - classification - Static and dynamic characteristics- calibration - classification of aircraft instruments - Instrument displays panels and cockpit layout.

UNIT II AIR DATA INSTRUMENTS AND SYNCHRO TRANSMISSION SYSTEMS 9
Air data instruments-airspeed, altitude, Vertical speed indicators. Static Air temperature, Angle of attack measurement, Synchronous data transmission system

UNIT III GYROSCOPIC INSTRUMENTS 9
Gyroscope and its properties, gyro system, Gyro horizon, Direction gyro-direction indicator, Rate gyro-rate of turn and slip indicator, Turn coordinator, acceleration and turning errors.

UNIT IV AIRCRAFT COMPASS SYSTEMS&FLIGHT MANAGEMENT SYSTEM 9
Direct reading compass, magnetic heading reference system-detector element, monitored gyroscope system, DGU, RMI, deviation compensator. FMS- Flight planning-flight path optimization-operational modes-4D flight management

UNIT V POWER PLANT INSTRUMENTS 9
Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, fuel flow, engine vibration, monitoring.

L : 45, T :15 TOTAL: 45 PERIODS

REFERENCES:
1. Pallet, E.H.J. "Aircraft Instruments & Integrated systems", Longman Scientific and Technical, McGraw-Hill, 1992.
2. Murthy, D.V.S., "Transducers and Measurements", McGraw-Hill, 1995
3. Doeblin.E.O, "Measurement Systems Application and Design", McGraw-Hill, New York, 1999.
4. Harry.Stilz, "Aerospace Telemetry", Vol I to IV, Prentice-Hall Space Technology Series.

MA7170 ADVANCED MATHEMATICAL METHODS

L	T	P	C
3	1	0	4

OBJECTIVES:

- To familiarize the students in differential equations for solving boundary value problems associated with engineering applications.
- To expose the students to calculus of variation, conformal mappings and tensor analysis.

OUTCOME:

- This subject helps to develop the mathematical methods of applied mathematics and mathematical physics with an emphasis on calculus of variation and integral transforms.

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS (9+3)

Laplace transform: Definitions, properties -Transform of error function, Bessel's function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations: Heat equation, Wave equation.

UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS (9+3)

Fourier transform: Definitions, properties -Transform of elementary functions, Dirac Delta function – Convolution theorem – Parseval's identity– Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poison's equations.

UNIT III CALCULUS OF VARIATIONS (9+3)

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – problems with constraints - Direct methods: Ritz and Kantorovich methods.

UNIT IV CONFORMAL MAPPING AND APPLICATIONS (9+3)

Introduction to conformal mappings and bilinear transformations - Schwarz- Christoffel transformation – Transformation of boundaries in parametric form – Physical applications: Fluid flow and heat flow problems.

UNIT V TENSOR ANALYSIS (9+3)

Summation convention – Contravariant and covariant vectors – contraction of tensors – innerproduct – quotient law – metric tensor – Christoffel symbols – covariant differentiation – gradient, divergence and curl.

TOTAL: 60 PERIODS

BOOKS FOR STUDY:

1. Sankara Rao K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi,1997.
2. Gupta A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3. Spiegel M.R., "Theory and Problems of Complex Variables and its Application"(Schaum's Outline Series), McGraw Hill Book Co., Singapore,1981.
4. Ramanaiah, G.T., "Tensor Analysis", S. Viswanatthan Pvt. Ltd., 1990.
5. James G., "Advanced Modern Engineering Mathematics", Pearson Education, Third Edition, 2004.
6. O'Neil P.V., "Advanced Engineering Mathematics", Thomson Asia Pvt. Ltd., Singapore, 2003.

REFERENCES:

1. Andrew L.C. and Shivamoggi B.K., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Elsgolts L., "Differential Equations and the Calculus of Variations", MIR Publishers, Moscow, 1973.
3. Mathews J.H. and Howell R.W., "Complex Analysis for Mathematics and Engineering", Narosa Publishing House, New Delhi,1997.
4. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, Fortieth Edition, 2007

AS7111 **AERODYNAMICS LABORATORY** **L T P C**
0 0 4 2

OUTCOME:

Upon completion of the course, students will be in a position to use wind tunnel for pressure and force measurements on various models.

LIST OF EXPERIMENTS

1. Calibration of subsonic wind tunnel
2. Pressure distribution over a smooth and rough cylinders
3. Pressure distribution over a symmetric aerofoil section
4. Pressure distribution over a cambered aerofoil section
5. Force and moment measurements using wind tunnel balance
6. Pressure distribution over a wing of symmetric aerofoil section
7. Pressure distribution over a wing of cambered aerofoil section
8. Flow visualization studies in incompressible flows
9. Calibration of supersonic wind tunnel
10. Supersonic flow visualization studies

TOTAL: 60 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS

1. Subsonic wind tunnel
2. Rough and smooth cylinder
3. Symmetrical Cambered aerofoil
4. Wind tunnel balance
5. Schlieren system
6. Pressure Transducers

AS7112 **AEROSPACE PROPULSION LABORATORY** **L T P C**
0 0 4 2

OUTCOME:

Upon completion of the course, students will get practical experience on jets and pressure measurements on combustor.

LIST OF EXPERIMENTS

1. Total pressure measurements along the jet axis of a circular supersonic jet
2. Total pressure measurements along the jet axis of a non circular supersonic jet
3. Performance studies of a hybrid rocket propulsion system
4. Cold flow studies of a wake region behind flame holders
5. Wall pressure measurements of a non circular combustor
6. Wall pressure measurements of a subsonic diffuser
7. Ignition delay measurements of a solid propellant
8. Wall pressure measurements of an isolator of a supersonic combustor (cold flow studies)
9. DSC and TGA studies on HTPB
10. Cascade testing of compressor blades.

TOTAL: 60 PERIODS

SEMESTER II (LVT)

AS7201 MISSILE GUIDANCE AND CONTROL

	L	T	P	C
	3	0	0	3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of missile guidance and control to the engineers and to provide the necessary mathematical knowledge that are needed in understanding the physical processes. The students will have an exposure on various topics such as missile systems, missile airframes, autopilots, guidance laws and will be able to deploy these skills effectively in the understanding of missile guidance and control.

UNIT I MISSILE SYSTEMS INTRODUCTION 8

History of guided missile for defence applications- Classification of missiles– The Generalized Missile Equations of Motion- Coordinate Systems- Lagrange’s Equations for Rotating Coordinate Systems- Rigid-Body Equations of Motion-missile system elements, missile ground systems.

UNIT II MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL 9

Missile aerodynamics- Force Equations, Moment Equations, Phases of missile flight. Missile control configurations. Missile Mathematical Model. Autopilots — Definitions, Types of Autopilots, Example Applications. Open-loop autopilots. Inertial instruments and feedback. Autopilot response, stability, and agility- Pitch Autopilot Design, Pitch-Yaw-Roll Autopilot Design.

UNIT III MISSILE GUIDANCE LAWS 10

Tactical Guidance Intercept Techniques, Derivation of the Fundamental Guidance Equations, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance, Three-Dimensional Proportional Navigation, comparison of guidance system performance, Application of Optimal Control of Linear Feedback Systems.

UNIT IV STRATEGIC MISSILES 10

Introduction, The Two-Body Problem, Lambert’s Theorem, First-Order Motion of a Ballistic Missile , Correlated Velocity and Velocity-to-Be-Gained Concepts, Derivation of the Force Equation for Ballistic Missiles, Atmospheric Reentry, Ballistic Missile Intercept, Missile Tracking Equations of Motion, Introduction to Cruise Missiles , The Terrain-Contour Matching (TERCOM) Concept.

UNIT V WEAPON DELIVERY SYSTEMS 8

Weapon Delivery Requirements, Factors Influencing Weapon Delivery Accuracy, Unguided Weapons, The Bombing Problem, Guided Weapons, Integrated Flight Control in Weapon Delivery, Missile Launch Envelope, Mathematical Considerations Pertaining to the Accuracy of Weapon Delivery Computations.

L : 45, TOTAL: 45 PERIODS

REFERENCES:

1. Siouris, G.M. "Missile Guidance and control systems", Springer, 2003.
2. Blakelock, J. H.; Automatic Control of Aircraft and Missiles, 2nd Edition, John Wiley & Sons, 1990.
3. Fleeman, Eugene L.; Tactical Missile Design, First Edition, AIAA Education series, 2001.
4. Garnell, P., "Guided Weapon Control Systems", 2nd Edition, Pergamon Press, 1980.
5. Joseph Ben Asher and Isaac Yaesh “Advances in Missile Guidance Theory” AIAA Education series, 1998
6. Paul Zarchan “Tactical and Strategic Missile Guidance” AIAA Education series,2007

AO7202 **FINITE ELEMENT METHODS** **L T P C**

3 1 0 4

OUTCOME:

Upon completion of the course, students will learn the concept of numerical analysis of structural components

UNIT I INTRODUCTION 12

Review of various approximate methods – Rayleigh-Ritz, Galerkin and Finite Difference Methods - Stiffness and flexibility matrices for simple cases - Basic concepts of finite element method - Formulation of governing equations and convergence criteria.

UNIT II DISCRETE ELEMENTS 14

Structural analysis of bar and beam elements for static and dynamic loadings. Bar of varying section – Temperature effects

Program Development and use of software package for application of bar and beam elements for static, dynamic and stability analysis.

UNIT III CONTINUUM ELEMENTS 14

Plane stress, Plane strain and Axisymmetric problems – CST Element – LST Element. Consistent and lumped load vectors. Use of local co-ordinates. Numerical integration. Application to heat transfer problems.

Solution for 2-D problems (static analysis and heat transfer) using software packages.

UNIT IV ISOPARAMETRIC ELEMENTS 12

Definition and use of different forms of 2-D and 3-D elements. - Formulation of element stiffness matrix and load vector.

Solution for 2-D problems (static analysis and heat transfer) using software packages.

UNIT V SOLUTION SCHEMES 8

Different methods of solution of simultaneous equations governing static, dynamics and stability problems. General purpose Software packages.

TOTAL: 60 PERIODS

REFERENCES

1. Segerlind,L.J. “Applied Finite Element Analysis”, Second Edition, John Wiley and Sons Inc., New York, 1984.
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002
3. S.S.Rao, “Finite Element Method in Engineering”, Butterworth, Heinemann Publishing, 3rd Edition, 1998
4. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt “Concepts and Applications of Finite Element Analysis”, 4th Edition, John Wiley & Sons, 2002.
5. K.J. Bathe and E.L. Wilson, “Numerical Methods in Finite Elements Analysis”, Prentice Hall of India Ltd., 1983.
6. C.S. Krishnamurthy, “Finite Elements Analysis”, Tata McGraw-Hill, 1987.

AS7202 **LAUNCH VEHICLE AERODYNAMICS** **L T P C**
3 0 0 3

OUTCOME:
Upon completion of the course, Students will learn the concept of high speed aerodynamics and configurations of launch vehicles.

UNIT I BASICS OF HIGH SPEED AERODYNAMICS 9
Compressible flows-Isentropic relations-mathematical relations of flow properties across shock and expansion waves-fundamentals of Hypersonic Aerodynamics

UNIT II BOUNDARY LAYER THEORY 9
Basics of boundary layer theory-compressible boundary layer-shock shear layer interaction-Aerodynamic heating-heat transfer effects

UNIT III LAUNCH VEHICLE CONFIGURATIONS AND DRAG ESTIMATION 9
Types of Rockets and missiles-various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation

UNIT IV AERODYNAMICS OF SLENDER AND BLUNT BODIES 9
Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects.

UNIT V AERODYNAMIC ASPECTS OF LAUNCHING PHASE 9
Booster separation-cross wind effects-specific considerations in missile launching-missile integration and separation-methods of evaluation and determination- Stability and Control Characteristics of Launch Vehicle Configuration- Wind tunnel tests – Comparison with CFD Analysis.

L : 45, TOTAL: 45 PERIODS

REFERENCES:

1. Anderson, J.D., “Fundamentals of Aerodynamics”, McGraw-Hill Book Co., New York, 1985.
2. Chin SS, Missile Configuration Design, Mc Graw Hill, New York, 1961.
3. Anderson, J.D., “Hypersonic and High Temperature Gas Dynamics”, AIAA Education Series.
4. Nielson, Jack N, Stever, Gutford, “Missile Aerodynamics”, Mc Graw Hill, New York, 1960.
5. Anderson Jr., D., – “Modern compressible flows”, McGraw-Hill Book Co., New York 1999.
6. Charles D.Brown, “Spacecraft Mission Design”, AIAA Education Series, Published by AIAA, 1998
7. Elements of Space Technology for Aerospace Engineers”, Meyer Rudolph X, Academic Press, 1999

AO7018 **ROCKETRY AND SPACE MECHANICS** **L T P C**
3 0 0 3

OUTCOME:
Upon completion of the course, students will have an idea about solar system, basic concepts of orbital mechanics with particular emphasis on interplanetary trajectories.

UNIT I ORBITAL MECHANICS 9
Description of solar system – Kepler’s Laws of planetary motion – Newton’s Law of Universal gravitation – Two body and Three-body problems – Jacobi’s Integral, Librations points - Estimation of orbital and escape velocities

UNIT II SATELLITE DYNAMICS 9

Geosynchronous and geostationary satellites- factors determining life time of satellites – satellite perturbations – methods to calculate perturbations- Hohmann orbits – calculation of orbit parameters – Determination of satellite rectangular coordinates from orbital elements

UNIT III ROCKET MOTION 10

Principle of operation of rocket motor - thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories determinations of range and altitude – simple approximations to burnout velocity.

UNIT IV ROCKET AERODYNAMICS 9

Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – conical and bell shaped nozzles – adapted nozzles – rocket dispersion – launching problems.

UNIT V STAGING AND CONTROL OF ROCKET VEHICLES 8

Need for multistaging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles - SITVC.

TOTAL: 45 PERIODS

REFERENCES

1. G.P. Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1986.
2. J.W. Cornelisse, "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd., London, 1982
3. Van de Kamp, "Elements of astromechanics", Pitman Publishing Co., Ltd., London, 1980.
4. E.R. Parker, "Materials for Missiles and Spacecraft", McGraw-Hill Book Co., Inc., 1982.

AS7211	**STRUCTURES LABORATORY**	**L T P C**
		0 0 4 2

OUTCOME:

Upon completion of the course, Students will acquire experimental knowledge on the unsymmetrical bending of beams, finding the location of shear centre, obtaining the stresses in circular discs and beams using photoelastic techniques, calibration of photo – elastic materials.

LIST OF EXPERIMENTS

1. Constant strength Beams
2. Buckling of columns
3. Unsymmetrical Bending of Beams
4. Shear Centre Location for Open Section
5. Shear Centre Location for Closed Section
6. Flexibility Matrix for Cantilever Beam
7. Combined Loading
8. Calibration of Photo Elastic Materials
9. Stresses in Circular Disc Under Diametrical Compression – Photo Elastic Method
10. Vibration of Beams with Different Support Conditions
11. Determination of elastic constants of a composite laminate.
12. Wagner beam

NOTE: Any TEN experiments will be conducted out of 12.

TOTAL: 60 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS

1. Constant strength beam setup
2. Column setup
3. Unsymmetrical Bending setup
4. Experimental setup for location of shear centre (open & close section)
5. Cantilever beam setup
6. Experimental setup for bending and torsional loads
7. Diffuser transmission type Polaris cope with accessories
8. Experimental setup for vibration of beams
9. Universal Testing Machine
10. Wagner beam setup

SEMESTER II (ST)

AS7203 SPACECRAFT POWER SYSTEMS **L T P C**
3 0 0 3

OUTCOME:

Upon completion of the course, students will understand the advanced concepts of Spacecraft power systems and to provide the necessary mathematical knowledge that are needed in modeling the navigation process and methods. The students will have an exposure on various Power system elements,energy storage technology and power converters and will be able to deploy these skills effectively in the analysis and understanding of power systems in an spacecraft.

UNIT I SPACECRAFT ENVIRONMENT & DESIGN CONSIDERATION 9

Orbit definition /Mission Requirements of LEO, GEO, GTO & HEO, Lunar orbits, IPO with respect to Power Generation – Power System Elements - Solar aspect angle Variations

UNIT II POWER GENERATION 9

Study of Solar spectrum - Solar cells - Solar Panel design - Solar Panel Realization – Solar Panel testing - Effects of Solar cells and panels (IR, UV, Particles)

UNIT III ENERGY STORAGE TECHNOLOGY 9

Types of batteries – Primary & Secondary batteries - Nickel Cadmium - Nickel-Hydrogen – Nickel metal hydride - Lithium-ion –Lithium Polymer - Silver Zinc– Electrical circuit model – Performance characteristics of batteries - Application of batteries in launch vehicles and satellites – Fuel Cell – Polymer Electrolyte membrane Fuel Cell – Regenerative Fuel Cell

UNIT IV POWER CONVERTERS 9

DC – DC converters – Basic Convertors - Buck, Boost, Buck- boost converter –Derived converters: Fly back converter – Transformer coupled forward converter – Push-Pull converter - CUKs convertor– Resonant converter – Voltage and current regulators

UNIT V POWER CONTROL, CONDITIONING AND DISTRIBUTION 9

Solar Array Regulators – Battery changing schemes – Protection Schemes - Distribution – Harness - Thermal Design - EMI/EMC/ESD/Grounding schemes for various types of circuits and systems

L : 45, TOTAL: 45 PERIODS

REFERENCES

1. P R K Chetty, ‘Spacecraft Power Systems’, 1978.
2. Patel, Mukund R, ‘Spacecraft Power Systems’ CRC Press Boca Raton, 2005
3. Hyder, A k et.al, ‘ Space Power Technologies’ Imperial College Press London,2000
4. Fortescue, Peter et.al, ‘ Spacecraft Systems Engineering’ John Wiley England,2003.
5. Ned Mohan, et al,” Power Electronics, convertors Applications and Design”

AS7204 SPACECRAFT NAVIGATION SYSTEMS L T P C
3 0 0 3

OUTCOME:

Upon completion of the course, students will understand the advanced concepts of Spacecraft Navigation and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various Navigation systems such as Inertial Measurement systems, Satellite Navigation – GPS ; and will be able to deploy these skills effectively in the analysis and understanding of navigation systems in an spacecraft.

UNIT I NAVIGATION CONCEPTS 10

Fundamentals of spacecraft navigation systems and Position Fixing – Geometric concepts of Navigation – Elements - The Earth in inertial space - Earth's Rotation - Revolution of Earth - Different Coordinate Systems – Coordinates Transformation - Euler angle formulations - Direction cosine formulation - Quaternion formulation.

UNIT II GYRO SYSTEMS 8

Gyroscopes -Types – Mechanical - Electromechanical-Optical Gyro -Ring Laser gyro- Fiber optic gyro - Rate Gyro, Rate Integrating Gyro, Free Gyro, Vertical Gyro, Directional Gyro, Analysis & Applications

UNIT III INERTIAL NAVIGATION SYSTEMS 10

Accelerometers – Pendulous type – Force Balance type – MEMs Accelerometers - Basic Principles of Inertial Navigation – Types - Platform and Strap down - Mechanization INS system - Rate Corrections - Block diagram – Acceleration errors – -Coriolis effect - Schuler Tuning - Cross coupling - Gimbal lock - Alignment.

UNIT IV GPS & HYBRID NAVIGATION SYSTEMS 9

GPS overview – Concept – GPS Signal – Signal Structure- GPS data – Signal Processing – GPS Clock – GPS for position and velocity determination – DGPS Concepts - LAAS & WAAS Technology - Hybrid Navigation - Introduction to Kalman filtering – Case Studies -Integration of GPS and INS using Kalman Filter.

UNIT V RELATIVE NAVIGATION SYSTEMS 8

Relative Navigation – fundamentals – Equations of Relative Motion for circular orbits (Clohessy_Wiltshire Equations) - Sensors for Rendezvous Navigation - RF Sensors -Relative Satellite Navigation - Differential GSP - Relative GPS- Optical rendezvous sensors (Laser type and Camera type) -Formation Flying - Figure of Merit (FOM)

TOTAL: 45 PERIODS

REFERENCES:

1. Maxwell Noton, "Spacecraft navigation and guidance", Springer (London, New York), 1998
2. Slater, J.M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design", McGraw-Hill Book Company, New York, 1964.
3. Albert D. Helfrick, 'Modern Aviation Electronics', Second Edition, Prentice Hall Career & Technology, 1994
4. George M Siouris, 'Aerospace Avionics System; A Modern Synthesis', Academic Press Inc., 1993
5. Myron Kyton, Walfred Fried, 'Avionics Navigation Systems', John Wiley & Sons, 1997
6. Tsui. J. B.Y, "Fundamentals of Global Positioning System Receiver", John Wiley an Sons Inc, 2000

AS7205 SPACECRAFT COMMUNICATION SYSTEMS L T P C
3 0 0 3

OUTCOME:
Upon completion of the course, students will understand the advanced concepts of Spacecraft communication systems and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various elements of satellite communication,multiple access techniques and will be able to deploy these skills effectively in the analysis and understanding of communication systems in an spacecraft.

UNIT I ELEMENTS OF SATELLITE COMMUNICATION 8
Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Satellite – description of different Communication subsystems, Bandwidth allocation.

UNIT II TRANSMISSION, MULTIPLEXING, MULTIPLE ACCESS AND CODING 12
Different modulation and Multiplexing Schemes, Multiple Access Techniques FDMA, TDMA, CDMA, and DAMA, Coding Schemes, Satellite Packet Communications.

UNIT III SATELLITE LINK DESIGN 9
Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse.

UNIT IV SATELLITE TELEMETRY, TRACKING AND TELECOMMAND 9
Introduction to telemetry systems - Aerospace transducer - signal conditioning – multiplexing methods - Analog and digital telemetry - Command line and remote control system - Application of telemetry in spacecraft systems - Base Band Telemetry system - Computer command & Data handling , Satellite command system-Issues

UNIT V APPLICATIONS 7
VSAT-VSAT Technologies, Networks MSS-AMSS, MMSS

TOTAL: 45 PERIODS

REFERENCES:

1. Wilbur L. Pritchard and Joseph A.Sciulli, Satellite Communication Systems Engineering, Prentice Hall, New Jersey, 1986.
2. Timothy Pratt and Charles W.Bostain, Satellite Communications, John Wiley and Sons, 1986.
3. Tri T Ha, Digital Satellite Communication, Macmillan Publishing Company, 1986.
4. Kadish, Jules E, Satellite Communications Fundamentals, Artech House, Boston 2000
5. Lida,Takashi ed.,Satellite communications:System and its design technology, Ohmsha Tokyo 2000
6. Maral, Gerard,Satellite communications systems: Systems, techniques and technology, John Wiley, Newyork 2002.
7. Elbert, Bruce R, Satellite communication applications handbook, Artech house Boston 2004.

AO7018 ROCKETRY AND SPACE MECHANICS L T P C
3 0 0 3

OUTCOME:
Upon completion of the course, students will have an idea about solar system, basic concepts of orbital mechanics with particular emphasis on interplanetary trajectories.

UNIT I ORBITAL MECHANICS 9

Description of solar system – Kepler's Laws of planetary motion – Newton's Law of Universal gravitation – Two body and Three-body problems – Jacobi's Integral, Librations points - Estimation of orbital and escape velocities

UNIT II SATELLITE DYNAMICS 9

Geosynchronous and geostationary satellites- factors determining life time of satellites – satellite perturbations – methods to calculate perturbations- Hohmann orbits – calculation of orbit parameters – Determination of satellite rectangular coordinates from orbital elements

UNIT III ROCKET MOTION 10

Principle of operation of rocket motor - thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories determinations of range and altitude – simple approximations to burnout velocity.

UNIT IV ROCKET AERODYNAMICS 9

Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – conical and bell shaped nozzles – adapted nozzles – rocket dispersion – launching problems.

UNIT V STAGING AND CONTROL OF ROCKET VEHICLES 8

Need for multistaging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles - SITVC.

TOTAL: 45 PERIODS

REFERENCES

1. G.P. Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1986.
2. J.W. Cornelisse, "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd., London, 1982
3. Van de Kamp, "Elements of astromechanics", Pitman Publishing Co., Ltd., London, 1980.
4. E.R. Parker, "Materials for Missiles and Spacecraft", McGraw-Hill Book Co., Inc., 1982.

AS7212 MODELING AND SIMULATION LABORATORY L T P C
0 0 4 2

1. Stability analysis using Root locus, Bode plot, Nyquist plot and Polar plot techniques
2. simulation of Hoffmann transfer
3. simulation of velocity calculations for orbit manoeuvring
4. simulation of time period calculations for orbital motion
5. simulation of orbit propagation
6. simulation of Attitude and orbital perturbations
7. study and implementation of frame conversions
8. Link budget analysis
9. simulation of Rocketry culmination and trajectory calculations
10. Simulink study of control mechanisms
11. Design of Kalman filters
12. study of sgp algorithms and Attitude sensors design

NOTE: Implementation using MATLAB, or any equivalent software.

TOTAL : 60 PERIODS

SEMESTER III (LVT)

AS7301 CHEMICAL ROCKET TECHNOLOGY

L	T	P	C
3	0	0	3

OUTCOME:

Upon completion of this course, students acquire knowledge in depth about chemical rocket propulsion

UNIT I SOLID ROCKET PROPULSION 9

Various subsystems of Solid rocket motor and their functions- Propellant grain design- erosive burning – L * instability – internal ballistics of solid rocket motor – types of ignites - igniter design considerations – special problems of solid rocket nozzles.

UNIT II LIQUID ROCKET PROPULSION 12

Classification of liquid rocket engines – rocket thrust control – thrust chamber and injector design considerations – various types of liquids rocket injectors – thrust chamber cooling- cryogenic rocket propulsion – problems peculiar to cryogenic engines- propellant slosh- combustion instability.

UNIT III HYBRID ROCKET PROPULSION 8

Standard and reverse hybrid propulsion systems – applications – current status and limitations – combustion mechanism – propellant system selection – internal ballistics of hybrid rocket systems.

UNIT IV PROPELLANT TECHNOLOGY 8

Selection criteria for solid and liquid rocket propellants – calculation of adiabatic flame temperature – assessment of rocket performance- selections of propellant formulation – determination of propellant burn rate and factors influencing the burn rate – solid propellant processing

UNIT V TESTING AND SAFETY 8

Static testing of rocket – instrumentation required – thrust Vs time – pressure Vs time diagrams – specific impulse calculation – safety procedures for testing of rockets and solid propellants –ignition delay testing.

L : 45, TOTAL: 45 PERIODS

REFERENCES

1. G.P. Sutton, “Rocket Propulsion Elements”. John Wiley & Sons Inc., New York, 5th Edition, 1986.
2. Cornelisse., J.W., “ Rocket Propulsion and space Dynamics” J.W.Freemav & Co. Ltd., London, 1982.
3. G.C Oates, “Aerothermodynamics of Aircraft Engine Components “, AIAA Education. Series 1985.
4. Mathur and Sharma R.P. “Gas turbine, Jet and Rocket Propulsion standard publishers and Distributors Delhi, 1988.

SEMESTER III (ST)

AS7302 SPACECRAFT GUIDANCE AND CONTROL **L T P C**
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of spacecraft guidance and control to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as attitude sensors, control actuators, attitude dynamics,missile and launch guidance and will be able to deploy these skills effectively in the understanding of spacecraft guidance and control.

UNIT 1 ATTITUDE SENSORS 8

Relative Attitude sensors – Gyroscopes, Motion reference Units, Absolute Attitude sensors – Horizon sensor, Orbital Gyrocompass, Earth sensors, sun sensors (Digital and analog), star sensor, Magnetometer

UNIT II CONTROL ACTUATORS 9

Thrusters, Momentum Wheel, Control Moment Gyros, Reaction wheel, Magnetic Torquers, Reaction Jets, Ion Propulsion, Electric propulsion, solar sails

UNIT III ATTITUDE DYNAMICS, ATTITUDE AND ORBITAL DISTURBANCES 9

Rigid Body Dynamics, Flexible body Dynamics, Slosh Dynamics, Drag, Solar radiation Pressure, Disturbances due to Celestial bodies

UNIT IV ATTITUDE STABILIZATION SCHEMES & ORBIT MANEUVERS 10

Spin, Dual spin, Gravity gradient, Zero momentum system, Momentum Biased system, Reaction control system, Single and Multiple Impulse orbit Adjustment, Hohmann Transfer, Station Keeping and fuel Budgeting

UNIT V MISSILE AND LAUNCH VEHICLE GUIDANCE 9

Operating principles and design of guidance laws, homing guidance laws- short range, Medium range and BVR missiles, Launch Vehicle- Introduction, Mission requirements, Implicit guidance schemes, Explicit guidance, Q guidance schemes

L : 45, TOTAL: 45 PERIODS

REFERENCES :

1. Marcel j. sidi, “Spacecraft Dynamics and control, A Practical Engineering Approach”, Cambridge University Press.
2. Kaplan m, “Modern Spacecraft Dynamics and control”, Wiley Press
3. James R Wertz , Spacecraft Attitude Determination and control, Reidel Publications.
4. Vladimir A Chobotov, ”Spacecraft Attitude Dynamics and Control (Orbit)”,Krieger Publishing Company Publishers
5. Blake Lock, J.H ‘Automatic control of Aircraft and missiles ‘, John Wiley Sons, New York, 1990.
6. Meyer Rudolph X, Elements of Space Technology for Aerospace Engineers”, Academic Press, 1999

LIST OF ELECTIVES FOR LAUNCH VEHICLE TECHNOLOGY STREAM

AS7001 AEROSPACE MATERIALS

L	T	P	C
3	0	0	3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of aerospace materials to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such elements of aerospace materials, mechanical behavior of materials, ceramics and composites and will be able to deploy these skills effectively in the understanding of aerospace materials.

UNIT I ELEMENTS OF AEROSPACE MATERIALS 9

Structure of solid materials – Atomic structure of materials – Crystal structure – Miller indices – Density – Packing factor – Space lattices – X-ray diffraction – Imperfection in crystals – general requirements of materials for aerospace applications

UNIT II MECHANICAL BEHAVIOUR OF MATERIALS 9

Linear and non linear elastic properties – Yielding, strain hardening, fracture, Bauchinger's effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.

UNIT III CORROSION & HEAT TREATMENT OF METALS AND ALLOYS 10

Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles

Heat treatment of carbon steels – aluminium alloys, magnesium alloys and titanium alloys – Effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys, powder metallurgy.

UNIT IV CERAMICS AND COMPOSITES 9

Introduction – physical metallurgy – modern ceramic materials – cermets - cutting tools – glass ceramic –production of semi fabricated forms - Plastics and rubber – Carbon/Carbon composites, Fabrication processes involved in metal matrix composites - shape memory alloys – applications in aerospace vehicle design

UNIT V HIGH TEMPERATURE MATERIALS CHARACTERIZATION 8

Classification, production and characteristics – Methods and testing – Determination of mechanical and thermal properties of materials at elevated temperatures – Application of these materials in Thermal protection systems of Aerospace vehicles – super alloys – High temperature material characterization.

L : 45, TOTAL: 45 PERIODS

REFERENCES

1. Titterton.G., Aircraft Materials and Processes, V Edition, Pitman Publishing Co., 1995.
2. Martin, J.W., Engineering Materials, Their properties and Applications, Wykedham Publications (London) Ltd., 1987.
3. Van Vlack.L.H., Materials Science for Engineers, Addison Wesley, 1985.
4. Raghavan.V., Materials Science and Engineering, Prentice Hall of India, New Delhi, 1993.

AS7002 RELIABILITY AND QUALITY ASSURANCE

	L	T	P	C
	3	0	0	3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of reliability and quality assurance manned space missions to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as missile space stations, space vs earth environment, life support systems, mission logistics and planning and will be able to deploy these skills effectively in the understanding of reliability and quality assurance.

UNIT I STATISTICAL QUALITY CONTROL 9

Methods and Philosophy of statistical process control – Control charts for variables Attributes – Cumulative sum and Exponentially weighted moving average control charts – Other SPC Techniques – Process – Capability analysis.

UNIT II ACCEPTANCE SAMPLING 9

Acceptance sampling problem – Single sampling plans for attributes – double multiple and sequential sampling – Military standards – The Dodge Roaming sampling plans.

UNIT III INTRODUCTION TO TQM 9

Need for quality – Definition of quality – Continuous process improvement – Contributions of Deming, Juran and Crosby - Basic concepts of TQM – Six Sigma: concepts, methodology, application to manufacturing

UNIT IV FAILURE DATA ANALYSIS RELIABILITY PREDICTION 9

Repair time distributions – Exponential, normal, log normal, gamma and Weibull – reliability data requirements – Graphical evaluation - Failure rate estimates – Effect of environment and stress – Series and Parallel systems – RDB analysis – Standby systems – Complex systems – Reliability demonstration testing – Reliability growth testing – Duane curve – Risk assessment – FMEA, Fault tree.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000, ISO 9000-2000 Quality system – Elements, Documentation, Quality auditing – QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL: 45 PERIODS

REFERENCES

1. John Bank, The Essence of Total Quality Management, Prentice Hall of India Pvt ltd., 1995
2. Mohamed Zairi, Total Quality Management for Engineers, Woodhead Publishing Ltd., 1991
3. Harvid Noori and Russel, Production and Operations Management – Total Quality and Responsiveness, McGraw Hill Inc., 1995
4. Suresh Dalela and Saurabh, ISO 900, A manual for Total Quality Management, S.Chand and Company Ltd., 1997.

AS7003 SYSTEMS ENGINEERING **L T P C**
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand to impart the the advanced concepts of systems engineering to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as conceptual system design,sytem design and development,design for operational feasibility,systems engineering management and will be able to deploy these skills effectively in the understanding of systems engineering.

UNIT I INTRODUCTION TO SYSTEM ENGINEERING 9

Overview, Systems definition and concepts, Conceptual system design, Systems thinking and Systems Engineering.

UNIT II DESIGN AND DEVELOPMENT 9

Detail Design Requirements, The Evolution of Detail Design, Design Data, Information, and Integration, Various phases in product life cycle, Systems verification & Integration

UNIT III DESIGN FOR OPERATIONAL FEASIBILITY 9

Design for Reliability, Maintainability, Usability, Sustainability and Affordability - Definition and Explanation, Measures, System Life Cycle cost, Analysis Methods, Practical considerations.

UNIT IV SYSTEMS ENGINEERING MANAGEMENT 9

Systems Engineering Planning and Organization, Systems Engineering Management Plan (SEMP), Program Leadership and Direction, Risk Management, Evaluation and Feedback.

UNIT V CASE STUDIES 9

Systems Integration -Aircraft Systems, Missile Systems, Satellite Systems-Launch Vehicle Systems and Radar, Design Drivers in the Project, Product, Operating Environment-Interfaces with the Subsystems.

, TOTAL: 45 PERIODS

REFERENCES:

1. Systems Engineering and Analysis by Benjamin S. Blanchard / Wolter J.Fabrycky, Prentice Hall, International Version 2010
2. Gandoff, M.,(1990). Systems Analysis and Design.
3. Systems Engineering by Erik Aslaksen and Rod Belcher.
4. Design and Development of an Aircraft Systems by Ian Moir and Allan Seabridge.
5. Introduction to Systems Engineering by Andrew P.Sage and James .Armstrong.

AS7004 TESTING AND INSTRUMENTATION OF AEROSPACE SYSTEMS **L T P C**
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of testing and instrumentation of aerospace systems to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as motion sensors, signal conditioning and fault diagnosis, telemetry systems and will be able to deploy these skills effectively in the understanding of instrumentation of aerospace systems.

UNIT I INTRODUCTION 6

Introduction- Basic concepts and principles of motion sensors and transducers-selection- testing procedures

UNIT II SIGNAL CONDITIONING AND FAULT DIAGNOSIS 9

Basics of measurements, amplifiers, filters, modulators and demodulators, bridge circuits, analog-digital conversion. System error analysis, fault diagnostics analysis for aerospace vehicles including case study

UNIT III TELEMETRY SYSTEM 10

System block diagram, Frequency and Time Division Multiplexing , Frequency Modulation - Pulse amplitude modulation - Pulse code modulation, Radio Link - Airborne and ground antennas, Link parameters - Design and analysis.

UNIT IV INSTRUMENTS TESTING 12

Autonomous instruments checkout and calibration built in test- ground test, In flight test, core tests for sensors and actuators, environmental effects, performance evaluation

UNIT V DAMAGE ASSESSMENT 8

Introduction, Damage assessment of aerospace instruments by various analyses. Case study – Sensors in Attitude measurements

TOTAL: 45 PERIODS

REFERENCES

1. Vibration Monitoring, Testing, and Instrumentation (Mechanical and Aerospace Engineering Series) "Clarence W. de Silva
2. HarryL.Stilz, "Aerospace Telemetry", Vol I to IV, Prentice-Hall Space Technology Series.
3. Rangan, C.S. Sharma, G.R. Mani, V.S.V., 'Instrumentation Devices and Systems', McGraw-Hill, 1986.

AS7005 SPACE WEAPONS AND WARFARE

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION 9

Fundamentals concepts in missile trajectories and satellite orbits – Bombardment satellites – directed energy weapons – general characteristics – use of laser for missile targets – kinetic energy weapons above the atmosphere – weapons against terrestrial targets – conventional weapons against terrestrial targets.

UNIT II EMPLOYMENT & COMMAND 9

Functions and tasks – component and sequence about commanding space weapon systems – Advantages with respect to access and reach, responsiveness, distance and difficulty in defending against the weapons – Limitations and uses and implications.

UNIT III BALLISTIC MISSILE DEFENCE 9

Introduction to ballistic missile defence – Theatre Ballistic Missiles (TBM) – Classification – threat assessment – limitations and uncertainties - Threat analysis for Boost phase interception – Typical assessment errors.

UNIT IV ARCHITECTURE AND EXTERNAL CUEING 9

Selection of defended assets and threat scenario – defence system qualities and constraints – defence architecture process and development – External cueing process and uses – calculation of launch point – cued acquisition – Defence planning using external cueing – Radar degraded performance multiple radars and cue sources – system characteristics and use of cues.

UNIT V INTERCEPTION GUIDANCE AND INTERCEPTION OF MANEUVERING TARGETS 9

Proportional navigation geometry – proportional navigation linearized system and zero miss distance proportional navigation – optimal guidance law – mathematical modeling of pursuit – evasion – solution with constrained evader – stochastic analysis.

TOTAL: 45 PERIODS

REFERENCE BOOKS

1. Space weapons and Earth wars by Sean Edwards, Bob Preston, Dand J Johnson and Jennifer Gross, 2002, RAND Publications, USA
2. Theatre Ballistic Missile Defense, Edited by Ben-Zion Naveh and Azrial Lorber, Progress in Astronautics and Aeronautics, Volume 192, published by AIAA, USA 2001

AS7006 CFD FOR AEROSPACE APPLICATIONS

L	T	P	C
3	0	2	4

OUTCOME:

Upon completion of the course, Students will learn the flow of dynamic fluids by computational methods.

UNIT I NUMERICAL SOLUTIONS OF SOME FLUID DYNAMICAL PROBLEMS 15

Basic fluid dynamics equations, Equations in general orthogonal coordinate system, Body fitted coordinate systems, Stability analysis of linear system. Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations, Numerical integration and shooting technique.

Numerical solution for CD nozzle isentropic flows and local similar solutions of boundary layer equations.

UNIT II GRID GENERATION 15

Need for grid generation – Various grid generation techniques – Algebraic, conformal and numerical grid generation – importance of grid control functions – boundary point control – orthogonality of grid lines at boundaries.

Elliptic grid generation using Laplace's equations for geometries like airfoil and CD nozzle.

UNIT III TRANSONIC RELAXATION TECHNIQUES 15

Small perturbation flows, Transonic small perturbation (TSP) equations, Central and backward difference schemes, conservation equations and shockpoint operator, Line relaxation techniques, Acceleration of convergence rate, Jameson's rotated difference scheme -stretching of coordinates, shock fitting techniques Flow in body fitted coordinate system.

Numerical solution of 1-D conduction- convection energy equation using time dependentmethods using both implicit and explicit schemes – application of time split method for the above equation and comparison of the results.

UNIT IV TIME DEPENDENT METHODS 15

Stability of solution, Explicit methods, Time split methods, Approximate factorization scheme, Unsteady transonic flow around airfoils. Some time dependent solutions of gas dynamic problems. Numerical solution of unsteady 2-D heat conduction problems using SLOR methods

UNIT V PANEL METHODS 15

Elements of two and three dimensional panels, panel singularities. Application of panel methods to incompressible, compressible, subsonic and supersonic flows.

Numerical solution of flow over a cylinder using 2-D panel methods using both vertex and source panel methods for lifting and non lifting cases respectively.

TOTAL: 75 PERIODS

REFERENCES

1. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002
2. C.Y.Chow, "Introduction to Computational Fluid Dynamics", John Wiley, 1979.
3. A.A. Hirsch, 'Introduction to Computational Fluid Dynamics", McGraw-Hill, 1989.
4. T.K.Bose, "Computation Fluid Dynamics" Wiley Eastern Ltd., 1988.
5. H.J. Wirz and J.J. Smeldern "Numerical Methods in Fluid Dynamics", McGraw-Hill & Co., 1978.
6. John D. Anderson, JR" Computational Fluid Dynamics", McGraw-Hill Book Co., Inc., New York, 1995.

AO7204 COMPOSITE MATERIALS AND STRUCTURES L T P C
3 0 0 3

OUTCOME:

Upon completion of the course, students will understand the fabrication, analysis and design of composite materials & structures.

UNIT I INTRODUCTION 10

Classification and characteristics of composite materials - Types of fiber and resin materials, functions and their properties – Application of composite to aircraft structures-Micromechanics-Mechanics of materials, Elasticity approaches-Mass and volume fraction of fibers and resins-Effect of voids, Effect of temperature and moisture.

UNIT II MACROMECHANICS 10

Hooke's law for orthotropic and anisotropic materials-Lamina stress-strain relations referred to natural axes and arbitrary axes.

UNIT III ANALYSIS OF LAMINATED COMPOSITES 10

Governing equations for anisotropic and orthotropic plates- Angle-ply and cross ply laminates-Analysis for simpler cases of composite plates and beams - Interlaminar stresses.

UNIT IV MANUFACTURING & FABRICATION PROCESSES 8

Manufacture of glass, boron and carbon fibers-Manufacture of FRP components- Open mould and closed mould processes. Properties and functions of resins.

UNIT V OTHER METHODS OF ANALYSIS AND FAILURE THEORY 7

Netting analysis- Failure criteria-Flexural rigidity of Sandwich beams and plates – composite repair-AE technique.

TOTAL: 45 PERIODS

REFERENCES
1. R.M. Jones, “Mechanics of Composite Materials”, 2nd Edition, Taylor & Francis, 1999
2. L.R. Calcote, “Analysis of laminated structures”, Van Nostrand Reinhold Co.,1989.
3 Autar K. Kaw, Mechanics of Composite Materials, CRC Press LLC, 1997
4. G.Lubin, “Hand Book on Fibre glass and advanced plastic composites”, Van Nostrand Co., New York, 1989.
5. B.D. Agarwal and L.J. Broutman, “Analysis and Performance of fiber composites”, John-Wiley and Sons, 1990.

AO7016 ADVANCED PROPULSION SYSTEMS L T P C
3 0 0 3

OUTCOME:
Upon completion of the course, students will learn in detail about gas turbines, ramjet, fundamentals of rocket propulsion and chemical rockets.

UNIT I THERMODYNAMIC CYCLE ANALYSIS OF AIR-BREATHING PROPULSION SYSTEMS 8
Air breathing propulsion systems like Turbojet, turboprop, ducted fan, Ramjet and Air augmented rockets – Thermodynamic cycles – Pulse propulsion – Combustion process in pulse jet engines – inlet charging process – Subcritical, Critical and Supercritical charging.

UNIT II RAMJETS AND AIR AUGMENTED ROCKETS 8
Preliminary performance calculations – Diffuser design with and without spike, Supersonic inlets – combustor and nozzle design – integral Ram rocket.

UNIT III SCRAMJET PROPULSION SYSTEM 12
Fundamental considerations of hypersonic air breathing vehicles – Preliminary concepts in engine airframe integration – calculation of propulsion flow path – flowpath integration – Various types of supersonic combustors – fundamental requirements of supersonic combustors – Mixing of fuel jets in supersonic cross flow – performance estimation of supersonic combustors.

UNIT IV NUCLEAR PROPULSION 9
Nuclear rocket engine design and performance – nuclear rocket reactors – nuclear rocket nozzles – nuclear rocket engine control – radioisotope propulsion – basic thruster configurations – thruster technology – heat source development – nozzle development – nozzle performance of radiosotope propulsion systems.

UNIT V ELECTRIC AND ION PROPULSION 8
Basic concepts in electric propulsion – power requirements and rocket efficiency – classification of thrusters – electrostatic thrusters – plasma thruster of the art and future trends – Fundamentals of ion propulsion – performance analysis – ion rocket engine.

TOTAL: 45 PERIODS

REFERENCES
1. G.P. Sutton, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York,1998.
2. William H. Heiser and David T. Pratt, Hypersonic Airbreathing propulsion, AIAA Education Series, 2001.
3. Fortescue and Stark, Spacecraft Systems Engineering, 1999.
4. Cumpsty, Jet propulsion, Cambridge University Press, 2003.

AO7015 COMPUTATIONAL HEAT TRANSFER

L	T	P	C
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OUTCOME:

Upon completion of the course, students will learn the concepts of computation applicable to heat transfer for practical applications.

UNIT I INTRODUCTION 9

Finite Difference Method-Introduction-Taylor's series expansion - Discretisation Methods Forward, backward and central differencing scheme for Ist order and second order Derivatives – Types of partial differential equations-Types of errors. Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition.
FDM - FEM - FVM.

UNIT II CONDUCTIVE HEAT TRANSFER 9

General 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates.
Computation(FDM) of One –dimensional steady state heat conduction –with Heat generation- without Heat generation- 2D-heat conduction problem with different boundary conditions- Numerical treatment for extended surfaces. Numerical treatment for 3D- Heat conduction.
Numerical treatment to 1D-steady heat conduction using FEM.

UNIT III TRANSIENT HEAT CONDUCTION 9

Introduction to Implicit, explicit Schemes and crank-Nicolson Schemes Computation(FDM) of One – dimensional un-steady heat conduction –with heat Generation-without Heat generation - 2D- transient heat conduction problem with different boundary conditions using Implicit, explicit Schemes. Importance of Courant number.
Analysis for I-D,2-D transient heat Conduction problems.

UNIT IV CONVECTIVE HEAT TRANSFER 9

Convection- Numerical treatment(FDM) of steady and unsteady 1-D and 2-d heat convection-diffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows. Upwind scheme. Stream function-vorticity approach-Creeping flow.

UNIT V RADIATIVE HEAT TRANSFER 9

Radiation fundamentals-Shape factor calculation-Radiosity method- Absorption Method-Montacalro method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method.
Developing a numerical code for 1D, 2D heat transfer problems.

TOTAL: 45 PERIODS

REFERENCES

1. Pletcher and Tennahils " Computational Heat Trasnfer"…..
2. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill Edition, 2003.
3. S.C. Sachdeva, "Fundamentals of Engineering Heat & Mass Transfer", Wiley Eastern Ltd., New Delhi, 1981.
3. John H. Lienhard, "A Heat Transfer Text Book", Prentice Hall Inc., 1981.
4. J.P. Holman, "Heat Transfer", McGraw-Hill Book Co., Inc., New York, 6th Edition, 1991.
5. John D. Anderson, JR" Computational Fluid Dynamics", McGraw-Hill Book Co., Inc., New York, 1995.
6. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002
7. C.Y.Chow, "Introduction to Computational Fluid Dynamics", John Wiley, 1979.

AO7009 FATIGUE AND FRACTURE MECHANICS L T P C
3 0 0 3

OUTCOME:
Upon completion of the course, students will learn about fracture behaviour, fatigue design and testing of structures.

UNIT I FATIGUE OF STRUCTURES 10
S.N. curves – Endurance limit – Effect of mean stress – Goodman, Gerber and Soderberg relations and diagrams – Notches and stress concentrations – Neuber's stress concentration factors – plastic stress concentration factors – Notched S-N curves.

UNIT II STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 8
Low cycle and high cycle fatigue – Coffin-Manson's relation – Transition life – Cyclic Strain hardening and softening – Analysis of load histories – Cycle counting techniques – Cumulative damage – Miner's theory – other theories.

UNIT III PHYSICAL ASPECTS OF FATIGUE 5
Phase in fatigue life – Crack initiation – Crack growth – Final fracture – Dislocations – Fatigue fracture surfaces.

UNIT IV FRACTURE MECHANICS 15
Strength of cracked bodies – potential energy and surface energy – Griffith's theory – Irwin – Orwin extension of Griffith's theory to ductile materials – Stress analysis of cracked bodies – Effect of thickness on fracture toughness – Stress intensity factors for typical geometries.

UNIT V FATIGUE DESIGN AND TESTING 7
Safe life and fail safe design philosophies – Importance of Fracture Mechanics in aerospace structure – Application to composite materials and structures.

TOTAL: 45 PERIODS

REFERENCES

1. D.Brock, "Elementary Engineering Fracture Mechanics", Noordhoff International Publishing Co., London, 1994.
2. J.F.Knott, "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London, 1983.
3. W.Barrois and L.Ripley, "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
4. C.G.Sih, "Mechanics of Fracture", Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.

AO7011 HYPERSONIC AERODYNAMICS L T P C
3 0 0 3

OUTCOME:
Upon completion of the course, students will learn basics of hypersonic flow, shock wave - boundary layer interaction and hypersonic aerodynamic heating.

UNIT I BASICS OF HYPERSONIC AERODYNAMICS 8
Thin shock layers – entropy layers – low density and high density flows – hypersonic flight paths hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS 9

Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties

UNIT III APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS‘ 9

Approximate methods hypersonic small disturbance equation and theory – thin shock layer theory – blast wave theory - entropy effects - rotational method of characteristics - hypersonic shock wave shapes and correlations.

UNIT IV VISCOUS HYPERSONIC FLOW THEORY 10

Navier–Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – heat flux estimation.

UNIT V VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Estimation of hypersonic boundary layer transition- Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

TOTAL: 45 PERIODS

REFERENCES

1. John D. Anderson, Jr, Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.
2. John.D.Anderson, Jr., Modern Compressible Flow with Historical perspective Hypersonic Series.
3. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series.
4. John T. Bertin, Hypersonic Aerothermodynamics, 1994 AIAA Inc., Washington D.

AO7005 STRUCTURAL DYNAMICS L T P C
3 0 0 3

OUTCOME:

Upon completion of the course, students will learn how to use the approximate methods for dynamic response of continuous systems.

UNIT I FORCE-DEFLECTION PROPERTIES OF STRUCTURES 10

Constraints and Generalized coordinates – Virtual work and generalized forces – Force – Deflection influence functions – stiffness and flexibility methods.

UNIT II PRINCIPLES OF DYNAMICS 10

Free, Damped and forced vibrations of systems with finite degrees of freedom. D”Alembert’s principle – Hamilton’s principle – Lagrange’s equations of motion and its applications.

UNIT III NATURAL MODES OF VIBRATION 10

Equations of motion for free vibrations. Solution of Eigen value problems – Normal coordinates and orthogonality conditions of eigen vectors.

UNIT IV ENERGY METHODS 8

Rayleigh’s principle and Rayleigh – Ritz method. Coupled natural modes. Effect of rotary inertia and shear on lateral vibrations of beams.

UNIT V APPROXIMATE METHODS 7

Approximate methods of evaluating the eigen values and the dynamic response of continuous systems. Application of Matrix methods for dynamic analysis.

TOTAL: 45 PERIODS

REFERENCES

1. W.C. Hurty and M.F. Rubinstein, "Dynamics of Structures", Prentice Hall of India Pvt., Ltd., New Delhi, 1987.
2. F.S.Tse, I.E. Morse and H.T. Hinkle, "Mechanical Vibration", Prentice Hall of India Pvt., Ltd., New Delhi, 1988.
3. R.K. Vierck, "Vibration Analysis", 2nd Edition, Thomas Y. Crowell & Co., Harper & Row Publishers, New York, U.S.A., 1989.
4. S.P. Timoshenko and D.H. Young, "Vibration Problems in Engineering", John Willey & Sons Inc., 1984.
5. Von. Karman and A.Biot, "Mathematical Methods in Engineering", McGraw-Hill Book Co., New York, 1985.

LIST OF ELECTIVES FOR SATELLITE TECHNOLOGY STREAM

AS7001 AEROSPACE MATERIALS L T P C
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of aerospace materials to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such elements of aerospace materials,mechanical behavior of materials,ceramics and composites and will be able to deploy these skills effectively in the understanding of aerospace materials.

UNIT I ELEMENTS OF AEROSPACE MATERIALS 9

Structure of solid materials – Atomic structure of materials – Crystal structure – Miller indices – Density – Packing factor – Space lattices – X-ray diffraction – Imperfection in crystals – general requirements of materials for aerospace applications

UNIT II MECHANICAL BEHAVIOUR OF MATERIALS 9

Linear and non linear elastic properties – Yielding, strain hardening, fracture, Bauchinger's effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.

UNIT III CORROSION & HEAT TREATMENT OF METALS AND ALLOYS 10

Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles

Heat treatment of carbon steels – aluminium alloys, magnesium alloys and titanium alloys – Effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys, powder metallurgy.

UNIT IV CERAMICS AND COMPOSITES 9

Introduction – physical metallurgy – modern ceramic materials – cermets - cutting tools – glass ceramic –production of semi fabricated forms - Plastics and rubber – Carbon/Carbon composites, Fabrication processes involved in metal matrix composites - shape memory alloys – applications in aerospace vehicle design

UNIT V HIGH TEMPERATURE MATERIALS CHARACTERIZATION 8

Classification, production and characteristics – Methods and testing – Determination of mechanical and thermal properties of materials at elevated temperatures – Application of these materials in Thermal protection systems of Aerospace vehicles – super alloys – High temperature material characterization.

L : 45, TOTAL: 45 PERIODS

REFERENCES

1. Titterton.G., Aircraft Materials and Processes, V Edition, Pitman Publishing Co., 1995.
2. Martin, J.W., Engineering Materials, Their properties and Applications, Wykedham Publications (London) Ltd., 1987.
3. Van Vlack.L.H., Materials Science for Engineers, Addison Wesley, 1985.
4. Raghavan.V., Materials Science and Engineering, Prentice Hall of India, New Delhi, 1993.

AS7002 RELIABILITY AND QUALITY ASSURANCE L T P C
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of reliability and quality assurance manned space missions to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as missile space stations, space vs earth environment, life support systems, mission logistics and planning and will be able to deploy these skills effectively in the understanding of reliability and quality assurance.

UNIT I STATISTICAL QUALITY CONTROL 9

Methods and Philosophy of statistical process control – Control charts for variables Attributes – Cumulative sum and Exponentially weighted moving average control charts – Other SPC Techniques – Process – Capability analysis.

UNIT II ACCEPTANCE SAMPLING 9

Acceptance sampling problem – Single sampling plans for attributes – double multiple and sequential sampling – Military standards – The Dodge Roaming sampling plans.

UNIT III INTRODUCTION TO TQM 9

Need for quality – Definition of quality – Continuous process improvement – Contributions of Deming, Juran and Crosby - Basic concepts of TQM – Six Sigma: concepts, methodology, application to manufacturing

UNIT IV FAILURE DATA ANALYSIS RELIABILITY PREDICTION 9

Repair time distributions – Exponential, normal, log normal, gamma and Weibull – reliability data requirements – Graphical evaluation - Failure rate estimates – Effect of environment and stress – Series and Parallel systems – RDB analysis – Standby systems – Complex systems – Reliability demonstration testing – Reliability growth testing – Duane curve – Risk assessment – FMEA, Fault tree.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000, ISO 9000-2000 Quality system – Elements, Documentation, Quality auditing – QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL: 45 PERIODS

REFERENCES
1. John Bank, The Essence of Total Quality Management, Prentice Hall of India Pvt ltd., 1995
2. Mohamed Zairi, Total Quality Management for Engineers, Woodhead Publishing Ltd., 1991
3. Harvid Noori and Russel, Production and Operations Management – Total Quality and Responsiveness, McGraw Hill Inc., 1995
4. Suresh Dalela and Saurabh, ISO 900, A manual for Total Quality Management, S. Chand and Company Ltd., 1997.

AS7003 SYSTEMS ENGINEERING L T P C
3 0 0 3

OUTCOME:
Upon completion of this course, students will understand to impart the the advanced concepts of systems engineering to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as conceptual system design,sytem design and development,design for operational feasibility,systems engineering management and will be able to deploy these skills effectively in the understanding of systems engineering.

UNIT I INTRODUCTION TO SYSTEM ENGINEERING 9
Overview, Systems definition and concepts, Conceptual system design, Systems thinking and Systems Engineering.

UNIT II DESIGN AND DEVELOPMENT 9
Detail Design Requirements, The Evolution of Detail Design, Design Data, Information, and Integration, Various phases in product life cycle, Systems verification & Integration

UNIT III DESIGN FOR OPERATIONAL FEASIBILITY 9
Design for Reliability, Maintainability, Usability, Sustainability and Affordability - Definition and Explanation, Measures, System Life Cycle cost, Analysis Methods, Practical considerations.

UNIT IV SYSTEMS ENGINEERING MANAGEMENT 9
Systems Engineering Planning and Organization, Systems Engineering Management Plan (SEMP), Program Leadership and Direction, Risk Management, Evaluation and Feedback.

UNIT V CASE STUDIES 9
Systems Integration -Aircraft Systems, Missile Systems, Satellite Systems-Launch Vehicle Systems and Radar, Design Drivers in the Project, Product, Operating Environment-Interfaces with the Subsystems.

TOTAL: 45 PERIODS

REFERENCES:
1. Systems Engineering and Analysis by Benjamin S. Blanchard / Wolter J.Fabrycky, Prentice Hall, International Version 2010
2. Gandoff, M.,(1990). Systems Analysis and Design.
3. Systems Engineering by Erik Aslaksen and Rod Belcher.
4. Design and Development of an Aircraft Systems by Ian Moir and Allan Seabridge.
5. Introduction to Systems Engineering by Andrew P.Sage and James .Armstrong.

AS7004 TESTING AND INSTRUMENTATION OF AEROSPACE SYSTEMS **L T P C**
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of testing and instrumentation of aerospace systems to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as motion sensors, signal conditioning and fault diagnosis, telemetry systems and will be able to deploy these skills effectively in the understanding of instrumentation of aerospace systems.

UNIT I INTRODUCTION 6

Introduction - Basic concepts and principles of motion sensors and transducers-selection - testing procedures

UNIT II SIGNAL CONDITIONING AND FAULT DIAGNOSIS 9

Basics of measurements, amplifiers, filters, modulators and demodulators, bridge circuits, analog-digital conversion. System error analysis, fault diagnostics analysis for aerospace vehicles including case study

UNIT III TELEMETRY SYSTEM 10

System block diagram, Frequency and Time Division Multiplexing , Frequency Modulation - Pulse amplitude modulation - Pulse code modulation, Radio Link - Airborne and ground antennas, Link parameters - Design and analysis.

UNIT IV INSTRUMENTS TESTING 12

Autonomous instruments checkout and calibration built in test- ground test, In flight test, core tests for sensors and actuators, environmental effects, performance evaluation

UNIT V DAMAGE ASSESSMENT 8

Introduction, Damage assessment of aerospace instruments by various analyses. Case study – Sensors in Attitude measurements

TOTAL: 45 PERIODS

REFERENCES

1. Vibration Monitoring, Testing, and Instrumentation (Mechanical and Aerospace Engineering Series) “Clarence W. de Silva
2. HarryL.Stilz, “Aerospace Telemetry”, Vol I to IV, Prentice-Hall Space Technology Series.
3. Rangan, C.S. Sharma, G.R. Mani, V.S.V., ‘Instrumentation Devices and Systems’, McGraw-Hill, 1986.

AS7007 DIGITAL IMAGE PROCESSING FOR AEROSPACE APPLICATIONS **L T P C**
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of Image processing for aerospace applications to the engineers and to provide the necessary mathematical knowledge that are needed in modeling physical processes.The students will have an exposure on various topics such as Image enhancement, Wavelet transforms, multi-resolution analysis and vision based navigation and control and will be able to deploy these skills effectively in the solution of problems in avionics engineering.

UNIT I FUNDAMENTALS OF IMAGE PROCESSING 9

Introduction – Elements of visual perception, Steps in Image Processing Systems – Image Acquisition – Sampling and Quantization – Pixel Relationships – Colour Fundamentals and Models, File Formats Introduction to the Mathematical tools

UNIT II IMAGE ENHANCEMENT 9

Spatial Domain Gray level Transformations Histogram Processing Spatial Filtering – Smoothing and Sharpening. Frequency Domain: Filtering in Frequency Domain – DFT, FFT, DCT, Smoothing and Sharpening filters – Homomorphic Filtering.

UNIT III IMAGE SEGMENTATION AND FEATURE ANALYSIS 9

Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation – Motion Segmentation, Feature Analysis and Extraction.

UNIT IV MULTI RESOLUTION ANALYSIS 9

Multi Resolution Analysis: Image Pyramids – Multi resolution expansion – Wavelet Transforms, Fast Wavelet transforms, Wavelet Packets.

UNIT V AEROSPACE APPLICATIONS 9

Principles of digital aerial photography- Sensors for aerial photography - Aerial Image Exploration - Photo-interpretation, objective analysis and image quality - Image Recognition - Image Classification – Image Fusion – Colour Image Processing - Video Motion Analysis – Case studies – vision based navigation and control.

TOTAL: 45 PERIODS

REFERENCES:

1. Rafael C.Gonzalez and Richard E.Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2008.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, “Image Processing, Analysis and Machine Vision”, Third Edition, Third Edition, Brooks Cole, 2008.
3. Anil K.Jain, “Fundamentals of Digital Image Processing”, Prentice-Hall India, 2007.
4. Madhuri A. Joshi, ‘Digital Image Processing: An Algorithmic Approach”, Prentice-Hall India, 2006.
5. Rafael C.Gonzalez , Richard E.Woods and Steven L. Eddins, “Digital Image Processing Using MATLAB”, First Edition, Pearson Education, 2004.
6. Ron Graham, Alexander Koh,”Digital Aerial Survey: Theory and Practice”, Whittles Publishing; First edition,2002

AS7008 MANNED SPACE MISSIONS

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OUTCOME:

Upon completion of this course, students will understand the advanced concepts of manned space missions to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as missile space stations, space vs earth environment, life support systems, mission logistics and planning and will be able to deploy these skills effectively in the understanding of manned space missions.

UNIT I INTRODUCTION 8

The physics of space - Current missions: space station, Moon mission,and Mars missions - Engineering challenges on Manned vs. unmanned missions - Scientific and technological gains from space programs - Salient features of Apollo and Space station missions – space shuttle mission –

UNIT II SPACE VS EARTH ENVIRONMENT 10

Atmosphere: Structure and Composition - - Atmosphere: Air Pressure, Temperature, and Density - Atmosphere: Meteoroid, Orbital Debris & Radiation Protection - Human Factors of Crewed Spaceflight, . Saftey of Crewed Spaceflight - Magnetosphere - Radiation Environment: Galactic Cosmic Radiation (GCR) , Solar Particle Events (SPE) - Radiation and the Human Body – Impact of microgravity and g forces on humans – space adaptation syndrome

UNIT III LIFE SUPPORT SYSTEMS AND COUNTERMEASURES 8

Life Support Systems and Space Survival Overview - - Environment Controlled Life Support Systems (ECLSS) - Human / Machine Interaction - - Human Factors in Control Design - Crew Accommodations

UNIT IV MISSION LOGISTICS AND PLANNING 10

Group Dynamics: Ground Communication and Support - Space Resources and Mission Planning - Space Mission Design: Rockets and Launch Vehicles - Orbital Selection and Astrodynamics , Entry, Descent, Landing, and Ascent, Designing and Sizing Space elements, Transfer, Entry, Landing, and Ascent Vehicles, Designing, Sizing, and Integrating a Surface Base, Planetary Surface Vehicles

UNIT V ALLIED TOPICS 9

Spacecraft Subsystems: Space Operations - Space Architecture, Attitude Determination and Control - Designing Power Systems - Extravehicular Activity (EVA) Systems - Space Robotics - Mission Operations for Crewed Spaceflight - Command, Control, and Communications Architecture

TOTAL: 45 PERIODS

REFERENCES

1. Larson, W. J. and Pranke, L. K., **Human Spaceflight: Mission Analysis and Design**, McGraw-Hill Higher Education, Washington, DC , 1999
2. McNamara, Bernard. 2000. **Into the Final Frontier: The Human Exploration of Space.** (Brooks Cole Publishing.)
3. Connors, M.M., Harrison, A.A., and Akins, F.R. 2005. **Living Aloft: Human Requirements for Extended Spaceflight,** University Press of the Pacific,Honolulu, Hawaii: ISBN: 1-4102-1983-6
4. Eckart, P. 1996. **Spaceflight Life Support and Biospherics**

AS7009 MATHEMATICAL MODELING AND SIMULATION L T P C
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of Mathematical Modeling and Simulation to the engineers and to provide the necessary mathematical knowledge that are needed in modeling physical processes. The students will have an exposure on various topics such as System Models, probability concepts in simulation and flight simulators and will be able to deploy these skills effectively in the understanding the concepts and working of a flight simulator.

UNIT I SYSTEM MODELS AND SIMULATION 7

Continuous and discrete systems, System modeling, Static models, Dynamic models, Principles used in modeling the techniques of simulation, Numerical computation techniques for models, Distributed lag models, Cobweb models.

UNIT II PROBABILITY, CONCEPTS IN SIMULATION 8

Stochastic Variables, Discrete probability functions, continuous probability function, Measure of probability functions, Continuous uniformly distributed random number, Congestion in systems, Arrival patterns, Various types of distribution.

UNIT III SYSTEM SIMULATION 10

Discrete events, Representation of time, Generation of arrival patterns, Simulation programming tasks, Gathering statistics, Counters and summary statistics, Simulation language. Continuous System models, Differential equation, Analog methods, digital analog simulators, Continuous system simulation language (CSSLs), Hybrid simulation, Simulation of an autopilot, Interactive systems.

UNIT IV SYSTEM DYNAMICS AND MATHEMATICAL MODELS FOR FLIGHT SIMULATION 12

Historical background growth and decay models, System dynamics diagrams, Multi – segment models, Representation of time delays, The Dynamo Language Elements of Mathematical models, Equation of motion, Representation of aerodynamics data, Aircraft systems, Structure and cockpit systems, Motion system, Visual system, Instructor's facilities.

UNIT V FLIGHT SIMULATOR AS A TRAINING DEVICE AND RESEARCH TOOL 8

Introduction, advantage of simulator, the effectiveness of Simulator, The user's role, Simulator Certification, Data sources, Validation, in- flight simulators

TOTAL: 45 PERIODS

REFERENCES:

1. Gordon. G., "System Simulation" , Prentice – Hall Inc., 1992.
2. Stables, K.J. and Rolfe, J.M. "Flight Simulation", Cambridge University Press, 1986.

AS7201 MISSILE GUIDANCE AND CONTROL

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OUTCOME:

Upon completion of this course, students will understand the advanced concepts of missile guidance and control to the engineers and to provide the necessary mathematical knowledge that are needed in understanding the physical processes. The students will have an exposure on various topics such as missile systems, missile airframes, autopilots, guidance laws and will be able to deploy these skills effectively in the understanding of missile guidance and control.

UNIT I MISSILE SYSTEMS INTRODUCTION 8

History of guided missile for defence applications- Classification of missiles– The Generalized Missile Equations of Motion- Coordinate Systems- Lagrange's Equations for Rotating Coordinate Systems-Rigid-Body Equations of Motion-missile system elements, missile ground systems.

UNIT II MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL 9

Missile aerodynamics- Force Equations, Moment Equations, Phases of missile flight. Missile control configurations. Missile Mathematical Model. Autopilots — Definitions, Types of Autopilots, Example Applications. Open-loop autopilots. Inertial instruments and feedback. Autopilot response, stability, and agility- Pitch Autopilot Design, Pitch-Yaw-Roll Autopilot Design.

UNIT III MISSILE GUIDANCE LAWS 10

Tactical Guidance Intercept Techniques, Derivation of the Fundamental Guidance Equations, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance, Three-Dimensional Proportional Navigation, comparison of guidance system performance, Application of Optimal Control of Linear Feedback Systems.

UNIT IV STRATEGIC MISSILES 10

Introduction, The Two-Body Problem, Lambert's Theorem, First-Order Motion of a Ballistic Missile, Correlated Velocity and Velocity-to-Be-Gained Concepts, Derivation of the Force Equation for Ballistic Missiles, Atmospheric Reentry, Ballistic Missile Intercept, Missile Tracking Equations of Motion, Introduction to Cruise Missiles , The Terrain-Contour Matching (TERCOM) Concept.

UNIT V WEAPON DELIVERY SYSTEMS 8

Weapon Delivery Requirements, Factors Influencing Weapon Delivery Accuracy, Unguided Weapons, The Bombing Problem, Guided Weapons, Integrated Flight Control in Weapon Delivery, Missile Launch Envelope, Mathematical Considerations Pertaining to the Accuracy of Weapon Delivery Computations.

TOTAL: 45 PERIODS

REFERENCES:

1. Siouris, G.M. "Missile Guidance and control systems", Springer, 2003.
2. Blakelock, J. H.; Automatic Control of Aircraft and Missiles, 2nd Edition, John Wiley & Sons, 1990.
3. Fleeman, Eugene L.; Tactical Missile Design, First Edition, AIAA Education series, 2001.
4. Garnell, P., "Guided Weapon Control Systems", 2nd Edition, Pergamon Press, 1980.
5. Joseph Ben Asher and Isaac Yaesh "Advances in Missile Guidance Theory" AIAA Education series, 1998
6. Paul Zarchan "Tactical and Strategic Missile Guidance" AIAA Education series,2007

AS7010 DIGITAL FLY-BY-WIRE CONTROL L T P C
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of Fly-by-wire to the engineers and to provide the necessary mathematical knowledge that are needed in understanding modern aircraft control strategies. The students will have an exposure on various topics such as evolution of FBW, Elements, architecture, design and design issues of DFBW and will be able to deploy these skills effectively in the analyzing and understanding modern control methods.

UNIT I INTRODUCTION TO FLY-BY-WIRE CONTROL 7

Need for FBW systems, Historical perspectives in design Programs-Douglas Long Beach Programs, WPAFB B 47 In House Program, LTV IAP, Sperry Phoenix Programs, CAS and SAS, CCV and ACT concepts.

UNIT II ELEMENTS OF DFBW CONTROL 9

Description of various elements of DFBW systems - Concept of redundancy and reliability, Fault coverage and redundant architecture

UNIT III DFBW ARCHITECTURES 9

Need for redundant architecture, discussion on triplex vs. quadruplex architecture for DFBW system, Concept of cross-strapping, Actuator command voting and servo force voting etc.

UNIT IV SOME REQUIREMENTS FOR DFBW SYSTEM DESIGN 9

Survivable Flight control System programs, ADP Phases-Simplex package Evaluation - FBW without Mechanical Backup-Survivable Stabilator Actuator package, Reliability requirements and their relevance to DFBW system design, redundant power supply requirements, Environmental and weight, volume constraints.

UNIT V DESIGN ISSUES IN DFBW SYSTEM DESIGN 11

Thermal consideration, Built-in-test features, reliable software development, Redundancy management (voting, monitoring), Failure and maintenance philosophies, Implementation, Issues of digital control laws, Generic failures in Hardware and software. Advanced concepts in DFBW System Design

TOTAL: 45 PERIODS

REFERENCES:

1. Vernon R Schmitt, James W Morris and Gavin D Jenny, "Fly By Wire-A Historical Perspective", SAE International, 1998.
2. AGARD-CP-137, "Advances in Control systems", (Chap.10, 17,21, 22, 23, 24)
3. AGARD-CP-384, "Active Control Systems Review", Evaluations and Projections.
4. AGARD-CP-260, "Stability and Control" (Chap.15)
5. 'Modern Air Combat', Salamander Books Ltd , 2001.

AS7011 FAULT TOLERANT COMPUTING L T P C
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of Fault Tolerance to the engineers and to provide the necessary mathematical knowledge that are needed in understanding the necessary procedures involved. The students will have an exposure on various topics such as Redundancy, Fault Tolerant system architecture and design, error handling and recovery and will be able to deploy these skills effectively in the solution of problems in avionics engineering.

UNIT I FAULT TOLERANCE 10

Principles of fault tolerance – redundancy – quantitative reliability – evaluation – exception handling. Application of fault tolerant systems in aircraft – reliability strategies – Fault Tolerant Processor – Hardware and software

UNIT II ERROR DETECTION 12

Measure for error detection – Mechanisms for error detection – Measures for damage confinement and damage assessment – Protection mechanisms – Protection in multi-level systems

UNIT III ERROR RECOVERY 12

Measures for error recovery – mechanisms for error recovery – check points and audit trials – the recovery cache – Concurrent processes – recovery for competing process – recovery for cooperating process – distributed systems – fault treatment – location and repair.

UNIT IV SOFTWARE FAULT TOLERANCE 4

The recovery block scheme – Implementation of recovery block – Acceptance – tests – run-time overheads

UNIT V SYSTEMS STRUCTURE AND RELIABILITY 7

System structure – systems model – Software / Hardware interaction and multi-level systems – atomic actions – systems reliability – systems specification - Erroneous transitions and states – component / design failure – errors and faults.

TOTAL: 45 PERIODS

REFERENCES:

1. Anderson and Lee, Fault tolerant principles and practice, Prentice – Hall, 1981
2. Siewiorek, C.P. and Swartz, R.S Theory and practice of reliable system design, McGraw – Hill, 1983.
3. John D. Musa, Anthony Jannino, Kzuhira, Okunito, Software reliability measurement, prediction and application, McGraw – Hill, 1989.

AS7012 SOFT COMPUTING FOR AVIONICS ENGINEERS L T P C
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of Soft-computing to the engineers and to provide the necessary mathematical knowledge that are needed in modeling the related processes.The students will have an exposure on various topics such as Neural Networks, Fuzzy logic and Neuro-fuzzy modeling and will be able to deploy these skills effectively in the solution of problems in avionics engineering.

UNIT I NEURAL NETWORKS 9

Supervised Learning Neural Networks – Perceptrons – Adaline – Back propagation Multilayer Perceptron – Radial Basis Function Networks – Unsupervised Learning Neutral Networks – Competitive Learning Networks – Kohonen Self-Organizing Networks – Counter Propagation Networks- Advances In Neural Networks.

UNIT II FUZZY SET THEORY 9

Fuzzy Sets – Basic Definition and Terminology – Set Theoretic Operations – Member Function Formulation and Parameterization – Fuzzy Rules And Reasoning – Extension Principle and Fuzzy Relations – Fuzzy IF-THEN Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Model – Sugeno Fuzzy Model – Tsukamoto Fuzzy Model – Input Space Partitioning and Fuzzy Modeling.

UNIT III OPTIMIZATION METHODS 9

Derivative Based Optimization – Derivative free Optimization - Genetic Algorithm – Design Issues In Genetic Algorithm , Genetic Modeling – Optimization of Membership Function and Rule Base using GA – Fuzzy Logic Controlled GA.

UNIT IV NEURAL AND FUZZY CONTROL SCHEMES 9

Direct and Indirect Neuro Control Schemes – Fuzzy Logic Controller – Familiarization of Neural Network and Fuzzy Logic Toolbox - Case Studies.

UNIT V NEURO FUZZY MODELLING 9

Fuzzification and Rule Base using ANN – Fuzzy Neuron – Adaptive Neuro-fuzzy Inference System – Architecture – Hybrid Learning Algorithm – Learning Methods that Cross fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modeling.

L : 45, TOTAL: 45 PERIODS

REFERENCES
1. “Neural Networks: Algorithms, Applications and Programming Techniques”, Freeman J.A. &D.M. Skapura, Addison Wesley,2000.
2. J.S.R.Jang, C.T.Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI, 2004, Pearson Education 2004.
3. Anderson J.A “An Introduction to Neural Networks”,PHI, 2001.
4. Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, McGraw-Hill, 1997.
5. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 2000.
6. S. Rajasekaran and G.A.V.Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2003.

AS7013 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY **L T P C**
3 0 0 3

OUTCOME:

Upon completion of this course, students will understand the advanced concepts of Electromagnetic interference and compatibility to the engineers and to provide the necessary knowledge that are needed in understanding physical processes.The students will have an exposure on various topics such Electromagnetic environment, EMI coupling, standards and measurement, control techniques and EMC design of PCBs and will be able to deploy these skills effectively in the solution of problems in avionics engineering.

UNIT I EM ENVIRONMENT 9

Concepts of EMI and EMC, Noise, Definitions, Practical concerns, Sources of EMI: Natural, Apparatus and Circuits, conducted and radiated EMI, Transient EMI, Effects of EMI on Airborne systems.

UNIT II EMI COUPLING PRINCIPLES 9

Conducted, Radiated and Transient Coupling, Common Impedance, Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply Coupling.

UNIT III EMI STANDARDS AND MEASUREMENTS 9

Units of specifications, Civilian standards, MIL461, 462, 704E,F standards, IEEE, ANSI, IEC standards. CE mark. EMI Test, Open Area Test Site, Precautions, Site imperfections and Errors, Measurement Antennas. Radiated interference measurements: EMI Shielded Chamber, Anechoic chamber, Reverberating chamber, TEM Cell. Conducted Interference measurements Common mode, Differential mode interferences Pulsed EMI Immunity, ESD, EFT tests, Surge testing.

UNIT IV EMI CONTROL TECHNIQUES 9

Shielding, Grounding, Bonding, Isolation Transformer, Transient Suppressors, EMC connectors, Gaskets, optoisolators, EMI Filters, Power line filter design, Signal Control, Component Selection and Mounting issues.

UNIT V EMC DESIGN OF PCBS 9

Digital Circuit radiation, Cross Talk in PCB traces, Impedance Control, Power Distribution Decoupling, Zoning, Propagation Delay Models, PCB Designs guidelines for reduced EMI.

TOTAL: 45 PERIODS

REFERENCES:

1. W. Prasad Kodali, “Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models”, IEEE Press, Newyork, 2001.
2. Henry W.Ott, “Noise Reduction Techniques in Electronic Systems ", 2nd Edition, John Wiley and Sons, Newyork, 1988.
3. Mark I. Montrose, Edward M. Nakauchi, “Testing for EMC compliance”, IEEE / Wiley Interscience, Newyork 2004.