SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with "A" Grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119.
Phone: 044 - 2450 3150 / 51 / 52 / 54 / 55 Fax: 044 - 2450 2344
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SAEX 1029	AIRCRAFT NAVIGATION, GUIDANCE AND CONTROL	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INERTIAL SENSORS **10 hrs**

Gyroscopes-Mechanical-electromechanical-Ring Laser gyro- Fiber optic gyro, Accelerometers

UNIT II INERTIAL NAVIGATION SYSTEMS **10 hrs**

INS components: transfer function and errors-The earth in inertial space, the coriolis effect-Mechanisation. Platform and Strap down, INS system block diagram, Different co-ordinate systems, Schuler loop, compensation errors, Gimbal lock, Alignment.

UNIT III RADIO NAVIGATION **10 hrs**

Different types of radio navigation- ADF, VOR/DME- Doppler –LORAN, DECCA and Omega – TACAN

UNIT IV APPROACH AND LANDING AIDS **10 hrs**

ILS, MLS, GLS - Ground controlled approach system - surveillance systems-radio altimeter, RNAV, Modern Navigation Aids

UNIT V SATELLITE NAVIGATION & HYBRID NAVIGATION **10 hrs**

Introduction to GPS -system description -basic principles -position and velocity determination-signal structure-DGPS, Introduction to Kalman filtering-Estimation and mixed mode navigation-Integration of GPS and INS-utilization of navigation systems in aircraft

(Computational problems must be given as assignments for each unit)

REFERENCES:

1. Myron Kyton, Walfred Fried, 'Avionics Navigation Systems', John Wiley & Sons,2nd edition, 1997
2. Nagaraja, N.S. "Elements of Electronic Navigation", Tata McGraw-Hill Pub. Co., New Delhi, 2nd edition, 1975.
3. George M Siouris, 'Aerospace Avionics System; A Modern Synthesis', Academic Press Inc., 1993.
4. Albert Helfrick, 'Practical Aircraft Electronic Systems', Prentice Hall Education, Career & Technology, 1995.
5. Albert D. Helfrick, 'Modern Aviation Electronics', Second Edition, Prentice Hall Career & Technology, 1994.
6. Sen, A.K. & Bhattacharya, A.B. "Radar System and Radar Aids to Navigation", Khanna Publishers, 1988.
7. Slater, J.M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design", McGraw-Hill Book Company, New York, 1964.

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SAEX1021	ROCKETS AND MISSILES	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I ROCKETS SYSTEM **10 hrs**

Ignition System in rockets - types of Igniters - Igniter Design Considerations - Design Consideration of liquid Rocket Combustion Chamber, Injector Propellant Feed Lines, Valves, Propellant Tanks Outlet and Helium Pressurized and Turbine feed Systems - Propellant Slash and Propellant Hammer - Elimination of Geysering Effect in Missiles - Combustion System of Solid Rockets.

UNIT II AERODYNAMICS OF ROCKETS AND MISSILES **10 hrs**

Airframe Components of Rockets and Missiles - Forces Acting on a Missile While Passing Through Atmosphere- Classification of Missiles - methods of Describing Aerodynamic Forces and Moments - Lateral Aerodynamic Moment Lateral Damping Moment and Longitudinal Moment of a Rocket - lift and Drag Forces - Drag Estimation - Body Upwash and Downwash in Missiles - Rocket Dispersion - Numerical Problems.

UNIT III ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 10 hrs

One Dimensional and Two Dimensional rocket Motions in Free Space and Homogeneous Gravitational Fields - description of Vertical, Inclined and Gravity Turn Trajectories - Determination of range and Altitude Simple Approximations to Burnout Velocity.

UNIT IV STAGING AND CONTROL OF ROCKETS AND MISSILES **10 hrs**

Rocket Vector Control – Methods, SITVC termination, Thrust determination, Multi staging of rockets - Vehicle Optimization - Stage Separation Dynamics - Separation Techniques, Types of aerodynamics control in missiles

UNIT V MATERIALS FOR ROCKETS AND MISSILES **10 hrs**

Selection of Materials - Special Requirements of Materials to Perform under Adverse Conditions.

(Computational problems must be given as assignments for each unit)

TEXT BOOK:

1. Sutton, G.P., et al., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 1993.

REFERENCE BOOKS:

1. Mathur, M., and Sharma, R.P., " Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi 1998.
2. Cornelisse, J.W., " Rocket Propulsion and Space Dynamics", J.W., Freeman & Co. Ltd., London, 1982.
3.Parket, E.R., " Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982

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SAEX4001	AERO CAD LAB – I Using any Softwares like PRO/E, CATIA, Solid Works, ANSYS, MSC / Nastran	L	T	P	Credits	Total Marks
		0	0	3	3	100

LIST OF EXPERIMENTS:

1. Modelling of various components using any modelling software
2. Static analysis on cantilever beam
3. Static analysis of forces in a simply supported beam
4. Static analysis- Plane truss
5. 2-D static stress analysis
6. 3-D static stress analysis
7. Stress distribution in a shrink fit
8. Natural frequencies of a spring mass system
9. Stress and modal analysis of a cylinder under pressure
10. Stress distribution and natural frequencies in indeterminate structure
11. Analysis of a model airplane wing

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SAEX4004	Aero Modelling Lab	L	T	P	Credits	Total Marks
		0	0	3	3	100

LIST OF EXPERIMENTS:

1. Study about historical background of airplanes
2. Component of airplanes and its function
3. Construction of glider
4. Construction of wings
5. Construction of Fuselage
6. Construction of tail plane
7. Assembly of a plane
8. Mounting of engine and controls
9. Training in flight manoeuvring through computer simulation
10. Testing of trainer flight model

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SAEX 1036	ADVANCED CONTROL SYSTEM DESIGN FOR AEROSPACE VEHICLES	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION **10 hrs**

Introduction and Motivation for Modern Control Design- Review of Classical Control Systems-Introduction to Basic Flight Mechanics and Flight Control Systems.-State Space Representation of Dynamical Systems.

UNIT II NON LINEAR SYSTEMS **10 hrs**

Linearization of Nonlinear Systems, Linearized Flight Mechanics-Review of Matrix Theory-time Response of Dynamical Systems in State Space form-Stability of Linear Systems-Controllability and Observability of Linear Systems.

UNIT III CONTROL SYSTEM DESIGN **10 hrs**

Pole Placement Control Design.-Pole Placement Observer Design - Static Optimization -Optimal Control Formulation; Linear Quadratic Regulator (LQR) Design- Application of Linear Control Theory to Autopilot Design of Aircrafts and Missiles-Gain Scheduling and Dynamic Inversion Design.

UNIT IV STABILITY ANALYSIS & LYAPUNOV THEORY **10 hrs**

Stability Analysis of Nonlinear Systems Using Lyapunov Theory-Neuro-Adaptive Design for Nonlinear Systems-Advanced Nonlinear Control of Aerospace Vehicles Using Dynamic Inversion and Neuro-Adaptive Design.

UNIT V NONLINEAR CONTROL DESIGN **10 hrs**

Nonlinear Control Design Using Back-stepping-An Overview of LQ Observer and Kalman Filtering-Nonlinear Observer Design.

(Computational problems must be given as assignments for each unit)

REFERENCES

1. N. S. Nise: Control Systems Engineering, 4th Ed., Wiley, 2004.
2. K. Ogata: Modern Control Engineering, 3rd Ed., Prentice Hall, 1999.
3. B. Friedland: Control System Design, McGraw Hill, 1986.
4. E. Bryson and Y-C Ho: Applied Optimal Control, Taylor and Francis, 1975
5. Mathukumalli Vidyasagar, Nonlinear systems analysis, 2nd Edition,SIAM, 2002
6.Hassan K. Khalil, Nonlinear systems, Macmillan Pub. Co., 1992

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SAEX 1038	FLIGHT CONTROL SYSTEM DESIGN	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO CONTROL SYSTEM DESIGN & FCS 10 hrs

Open vs. Closed Loop Control - Analogue, Digital and Logical Control - Industrial Controllers - Control System Design Objectives - Control System Design Cycle - Introduction to Flight Control Systems - History of FCS - Guidance, Navigation and Control - Flight Control Channels - Flight Control Methods - SAS vs. Autopilot

UNIT II AERODYNAMIC CONSIDERATIONS OF FLIGHT CONTROL SYSTEMS 10 hrs

Static and Dynamic Stability - Stability and Maneuverability - Static Margin - Variations of the Center of Pressure - Hinge Moment - Aeroelastic Effects- Control System Performance - Canard Control - Wing Control - Tail Control - Fin Configuration Effects- Side Jet Control-Thrust -Vector Control - Variation of Mass and CG

UNIT III SENSORS & ACTUATORS 10 hrs

Flight Control Sensors – Accelerometers- Gyroscopes-Angle of attack vane - Other sensors - Sensor Selection-Flight Control Actuators- Servomechanism- Reversible vs. Irreversible –Mechanisms-Hydraulic Actuators-Pneumatic Actuators- Electric Actuators

UNIT IV CONTROLLER DESIGN 10 hrs

An Overview of Controller Design-Design Using Frequency Response-Design Using Root Locus-Pole Placement Methods-Linearization and Transfer Functions of Flying Vehicles- Coordinate Systems-Equations of Motion-Roll, Pitch and Yaw Transfer Functions-Design of Aerodynamic Control System for Missiles-STT vs. BTT -Lateral Control System Design for STT-Roll Control-Control System Design for BTT-MIMO Based Design-Design of Single Channel Flight Control Systems

UNIT V AIRCRAFT CONTROL SYSTEM DESIGN 10 hrs

Longitudinal Control-Lateral Control- Attitude Control Systems -Flight Path Control Systems- Active Control Systems -Thrust Vector Control - Classifications and Applications - Mathematical Modeling - Control Architectures - Controller Design- Miscellaneous Topics - Sensitivity Analysis-Man in the Loop considerations-Parameter Optimization

(Computational problems must be given as assignments for each unit)

TEXT BOOKS:

1. Garnell, P., "Guided Weapon Control Systems", 2nd Edition, Pergamon Press, 1980.
2. McLean, D., "Automatic Flight Control Systems", Prentice Hall International (UK) Ltd, 1990.
3. Blakelock, J. H.; Automatic Control of Aircraft and Missiles, 2nd Edition, John Wiley & Sons, 1990.