Table of Contents – Aerospace Engineering

1. E16010781– Mathematical Analysis for Aerospace Engineers

Algebraic methods: polynomial division; quotients and remainders; use of factor and remainder

theorem; rules of order for partial fractions (including linear, repeated and quadratic factors); reduction of algebraic fractions to partial fractions

Exponential, trigonometric and hyperbolic functions: the nature of algebraic functions; relationship between exponential and logarithmic functions; reduction of exponential laws to linear form; solution of equations involving exponential and logarithmic expressions; relationship between trigonometric and hyperbolic identities; solution of equations involving hyperbolic functions

Arithmetic and geometric: notation for sequences; arithmetic and geometric progressions; the limit of a sequence; sigma notation; the sum of a series; arithmetic and geometric series; Pascal's triangle and the binomial theorem

Power series: expressing variables as power series functions and use series to find approximate values (eg exponential series, Maclaurin's series, binomial series)

Sinusoidal functions: review of the trigonometric ratios; Cartesian and polar co-ordinate systems; properties of the circle; radian measure; sinusoidal functions

Applications such as: angular velocity; angular acceleration; centripetal force; frequency; amplitude; phase; the production of complex waveforms using sinusoidal graphical synthesis; AC waveforms and phase shift

Trigonometric identities: relationship between trigonometric and hyperbolic identities; double angle and compound angle formulae and the conversion of products to sums and differences; use of trigonometric identities to solve trigonometric equations and simplify trigonometric expressions

The calculus: the concept of the limit and continuity; definition of the derivative; derivatives of standard functions; notion of the derivative and rates of change; differentiation of functions using the product, quotient and function of a function rules; integral calculus as the calculation of area and the inverse of differentiation; the indefinite integral and the constant of integration; standard integrals and the application of algebraic and trigonometric functions for their solution; the definite integral and area under curves

Further differentiation: second order and higher derivatives; logarithmic differentiation; differentiation of inverse trigonometric functions; differential coefficients of inverse hyperbolic functions

Further integration: integration by parts; integration by substitution; integration using partial fractions

Applications of the calculus: eg maxima and minima; points of inflexion; rates of change of temperature; distance and time; electrical capacitance; rms values; electrical circuit analysis; ac theory; electromagnetic fields; velocity and acceleration problems; complex stress and strain; engineering structures; simple harmonic motion; centroids; volumes of solids of revolution; second moments of area; moments of inertia; rules of Pappus; radius of gyration; thermodynamic work and heat energy

Engineering problems: eg stress and strain; torsion; motion; dynamic systems; oscillating systems; force systems; heat energy and thermodynamic systems; fluid flow; ac theory; electrical signals; information systems; transmission systems; electrical machines; electronics

Tabular and graphical form: data collection methods; histograms; bar charts; line diagrams; cumulative frequency diagrams; scatter plots

Central tendency and dispersion: the concept of central tendency and variance measurement; mean; median; mode; standard deviation; variance and interquartile range; application to engineering production

Regression, linear correlation: determine linear correlation coefficients and regression lines and apply linear regression and product moment correlation to a variety of engineering situations

Probability: interpretation of probability; probabilistic models; empirical variability; events and sets; mutually exclusive events; independent events; conditional probability; sample space and probability; addition law; product law; Bayes' theorem

Probability distributions: discrete and continuous distributions, introduction to the binomial, Poisson and normal distributions; use of the Normal distribution to estimate confidence intervals and use of these confidence intervals to estimate the reliability and quality of appropriate engineering components and systems.

Learning Outcomes

Applying math to complex real-world problems; combining mathematical theory , practical engineering and scientific computing to address today's technological challenges.

Book referenced

Advanced engineering mathematics-HK Dass
Advanced engineering mathematics- Erwin kreyszig

2. E16010784 – Basic Aerodynamics

Conformal Transformation: Complex potential function, Blasius theorem, principles of conformal transformation, Kutta Joukowski Transformation.

2-D Incompressible Flows around Thin Airfoils : Circulation and the generation of Lift, Bound vortex and starting vortex, Kutta condition, Glauert's thin airfoil, theory, thin symmetric flat plate airfoil, Circular arc foil, general thin airfoil section, the flapped airfoil. Determination of mean camber line shapes for uniform and linear distribution of circulation, flow about multi element airfoils.

Incompressible Flow about Wings of Finite Span: Downwash and Induced drag, Biot-Savart's law and Helormholtz's theorems. Vortex system around a lifting wing, Prandtl's classical lifting line theory, unswept wings, fundamental equations, elliptic lift distribution, influence of aspect ratio on lift and drag, drag polar and lift correlation to aspect ratio. Techniques for general spanwise distribution, monoplane equation, calcuation of lift and vortex induced drag, numerical problems based on above. Panel methods : General description of the panel methods. Vortex Lattie Method: wing as a surface covered by horse shoe vortices (HSV), velocity field due to a general HSV, application of boundary conditions and working out solution for a planar wing, extension to a swept wing.

Delta Wing Aerodynamics: Polhamus's leading edge suction analogy, preliminary calculations of lift coefficient, description of flow field, effect of aspect ratio on lift coefficient, leading edge extensions, high angle of attack effects.

Ground effect and formation flying.

Dynamics of a Compressible Inviscid Flow Field: Basic aerodynamic effects, second law of thermodynamics and irreversibility, (Recap from Fluid Mechanics of the relevant portion on adiabatic and isentropic flow in variable area stream tube). Characteristic Equation and Prandtl-Meyer flow, shock waves. Shock wave boundary layer interaction - an introduction.

Compressible Subsonic and Transonic Flows: Compressible Subsonic Flow: Linearized theory for subsonic compressible flow about a thin wing at small angles of attack.

Transonic Flow past unswept airfoils, swept wings at transonic speeds, Area-Rule, forward swept wing, Extension to transonic aircraft.

2-D Supersonic Flows around thin Airfoils: Linearized theory and its application for calculation of lift, drag and pitching moments.

Busemann's theory and shock expansion technique.

Introduction to CFD: CFD as a design tool; explicit and implicit methods; O,C,H types of grids, various space discretisation methods such as FDM, FVM, FEM; concept of state update formula.

Book referenced

Fundamental of aerodynamics- John D Anderson

Aerodynamics- L J Clancy

Aerodynamics for engineering students- E.L.Houghton and PW Carpanter

3. HND 116 - Electrical And Electronics Engineering

Series and parallel LCR circuits: voltage, current and power with sinewave signals; conditions for resonance (eg frequency response, impedance, Q factor); complex notation

Circuit performance: Tolerancing; effect of changes in component values

Circuit theorems: Norton; Kirchhoff; Thévenin; superposition; Maxim power

Circuit analysis: mesh; nodal; maximum power transfer; impedance matching

Single- and two-stage transistor amplifiers: analysis of bias; dc conditions; ac conditions; coupling; input impedance; output impedance; frequency response

Design, test and evaluate: a single-stage amplifier to a given specification; compare measured and theoretical results

Digital electronic devices: logic families (eg 74 series, 4000 series); comparison between families; circuits integration; identification of digital circuits in electro-mechanical systems

Combinational circuits: simplification methods; truth tables; single gate solutions; circuit simulation; testing

Construct and test: circuit designed should be bread-boarded or simulated using an appropriate computer software package

Learning Outcomes:

1 Be able to apply complex notation in the analysis of single phase circuits
2 Be able to apply circuit theory to the solution of circuit problems
3 Understand the operation of electronic amplifier circuits used in electro-mechanical systems
4 Be able to design and test digital electronic circuits used in electro-mechanical systems.

Book Referenced:

Ashfaq Hussain, Electrical Principles.
BL Theresa, A Textbook of Basic Electrical Engineering.

4. HND 110 - Communication and Navigation

Legal requirements: licensing; regulatory authorities; frequency of operation; spurious emissions

Amplitude modulation (AM) transmitters: principles of transmission (eg electromagnetic radiation, electromagnetic spectrum and propagation of radio waves); types and principles of modulation; use of block/flow diagrams to aid explanation of the operation and stages within a transmitter system
Receivers: principles of radio reception (eg demodulation, Automatic Gain Control (AGC), Automatic Frequency Control (AFC)); types of receivers; use of block/flow diagrams of radio receiver systems; operation of stages within receivers; effects of noise and interfering signals on radio reception; signal to noise
Receiver performance: use of measurement and test equipment (eg signal generator, power meter, oscilloscope, noise test set, spectrum analyser); performance characteristic (eg sensitivity, signal to noise, adjacent channel, image channel rejection ratios)
Type of radio navigation systems: instrument landing system (ILS); very high frequency (VHF) omni-directional radio range (VOR); automatic direction finding (ADF); distance measuring equipment (DME); logan and omegal; global positioning systems (GPS)
Principles of operation: frequency bands; aerial pattern; system block diagrams; hyperbolic patterns; signal formats; GPS position determination
Aircraft systems: use of block diagrams to identify and explain a typical integrated aircraft radio navigation system; operation of the complete system
Principle and operations: basic principles relating to Inertial navigation; Schuler tuning; block diagram of Schuler tuned INS; accelerometers; gyros; alignment and gyro compassing; errors; choice of platform axes; strap-down IN systems; aided IN systems; Kalman filters
Aircraft IN system: use of block diagram of complete IN system; applications of a typical align sequence; IN augmentation (eg using Doppler, GPS, Kalman Filter); operating principles of analogue computing systems as used in navigation systems
IN Problems: calculation on acceleration, velocity, distance; errors encountered in IN systems and how corrections are applied
Radar systems: pulsed; carrier wave (CW); primary; secondary; Doppler; applications of each system; use of block diagrams of typical radar systems
Parameters measured: range/bearing/height; radar equation; solve problems related to range/bearing/height.

Learning Outcome:

1. Analyse and explain the operation of a radio transmitter and receivers.
2. Investigate and describe the operation of aircraft radio navigation system.
3. Analyse aircraft inertial navigation systems.
4. Analyse pulsed and continuous wave aircraft radar systems.

Book Referenced:

Kennedy G and Davis B, Electronic communication system.

5. HND 106 - Engineering Drawing and Design

Plane Geometry: Construction of plane figures and curves used in Engineering Practice. Parabola, ellipse, hyperbola, rectangular hyperbola, cycloids, involutes of a circle, spiral.

Practical Solid Geometry : Projections, types of projections, first angle, first angle and third angle projection, projections of points, lines, traces of lines, projection of planes, projection of solid CG sections of solids such as prisms, pyramids, cylinders, cones and spheres. Development of surface for solids viz-cylinders and cone. Isometric scale and projection.

Machine Drawing: 1. Diagonal scales. 2. Types of lines, lettering and dimensioning. 3. Forms and proportions of bolts and nuts. 4. Engineering fastenings: (a) temporary - bolts and nuts and screws and nuts, etc., studs and nuts, keys cotters and pins; (b) permanent fastening-Riveted joints. 5. Helics and Screw threads. 6. Tolerances, Limits and fits.

Bearing wall brackets, shaft couplings, toothed gearing, bolt and rope pulleys.

Simple machine parts such as pistons, connecting rod ends, cross-heads, stuffing boxes, cranks and crankshafts, Eccentrics, valves, pipes and pipe joints.

Graphic statics : (1) Resultant of coplanar concurrent forces, force polygon, funicular polygon, conditions of equilibrium of a system of coplanar, concurrent and non-concurrent forces, resultant of parked forces. (2) Area centre of gravity and moment of inertia of plane figures 3 (a) Stresses in simple frames-subjected to dead load 3 (b) Stresses in roof trusses subjected to combined dead and wind loads.

Learning Outcome:
1. Prepare a design on A2 sheets using drafter and various types of pencils.
2. Draft a design which is used as raw form for computer-aided design.
3. Design various parts of machines using drafter and compass.

Book Referenced:
N.D. Bhatt, Engineering Drawing

6. HND 120 - Higher Engineering Mathematics

Error arithmetic: significant figures and estimation techniques; error arithmetic operations; systematic and random errors; application to experimentation and general laboratory work

Number systems: natural, integer, rational, reals, dinary, binary, octal and hexadecimal number systems; conversion from dinary to numbers of other bases and vice versa; two-state logic systems, binary numbers and logic gates, logic gate tables, application to logic circuits

Complex numbers: real and imaginary parts of complex numbers, complex number notation; Cartesian and polar forms; modulus, argument and complex conjugate; addition, subtraction, multiplication and division of Cartesian and polar forms; use of Argand diagrams; powers and roots and the use of de Moivre's theorem

Engineering applications: eg electric circuit analysis, phasors, transmission lines, information and energy control systems

Graphical techniques: Cartesian and polar co-ordinate systems and representation of complex number operations; vector representation; standard curves; asymptotes; systematic curve sketching; curve fitting; irregular areas and mean values of wave forms; use of phasor and Argand diagrams; application to engineering situations

Numerical integral: determine the integral of functions using mid-ordinate; trapezoidal and Simpson's rules

Numerical estimation methods: method of bisection; Newton-Raphson iteration method; estimates of scientific functions

Vector notation and operations: Cartesian co-ordinates and unit vectors; types of vector and vector representation; addition and subtraction; multiplication by a scalar; graphical methods

Matrix operations and vectors: carry out a range of matrix operations eg vectors in matrix form, square and rectangular matrices, row and column vectors, significance of the determinant, determinant for 2x2 matrix, the inverse of a 2x2 matrix; use Gaussian elimination to solve systems of linear equations (up to 3x3)

Vector geometry: determine scalar product, vector product, angle between two vectors, equation of a line, norm of a vector, dot and cross products; apply vector geometry to the solution of engineering problems (eg velocity vector and mechanisms, acceleration vector and mechanisms, forces in static frameworks and structures, evaluation of static joint structures using dot product, phasors)

First order differential equations: engineering use; separation of variables; integrating factor method, complementary function and particular integral

Numerical methods for first order differential equations: need for numerical solution; Euler's method; improved Euler method; Taylor series method

Application of first order differential equations: eg RC and RL electric circuits, time constants, motion with constant and variable acceleration, Fourier equation for heat transfer, Newton's laws of cooling, charge and discharge of electrical capacitors, complex stress and strain, metrology problems

Second order differential equations: engineering use; arbitrary constants; homogeneous and on homogeneous linear second order equations

Application of second order differential equations: eg RLC series and parallel circuits, undamped and damped mechanical oscillations, fluid systems, flight control laws, mass-spring-damper systems, translational and rotational motion systems, thermodynamic systems, information and energy control systems, heat transfer, automatic control systems, stress and strain, torsion, shells, beam theory

Engineering situations: applications (eg heat transfer, Newton's laws, growth and decay, mechanical systems, electrical systems, electronics, design, fluid systems, thermodynamics, control, statics, dynamics, energy systems, aerodynamics, vehicle systems, transmission and communication systems)

Learning Outcomes:

1. Analyses and model engineering situation and solve engineering problems using series and numerical methods for solution of ordinary differential equations.
2. Analyses and model engineering situation and solve engineering problems using Laplace transforms.
3. Analyses and model engineering situation and solve engineering problems using Fourier series.
4. analyses and model engineering situation and solve engineering problems using Partial differential equation.

Book Referenced:

BS. Grewal, Higher Engineering Mathematics.

7. E16010788 – Aerodynamics Principles and Aircraft Stability and Performance

Introduction to flight dynamics and experiments, Standard Atmosphere, Altitude and Airspeed

Introduction to Performance of Flight and Experiments,

Steady and level flight - Equations of motion, Drag polar and Trust required, Cruise Flight - Power required, Velocity for Minimum Power required, Cruise Flight - Thrust and Power available, Maximum and minimum cruise velocity, Effects of altitude on power , Cruise Flight - Range and Endurance of Propeller Driven Aircraft, Cruise Flight - Range and Endurance of Jet driven Aircraft, Estimation of profile Drag coefficient (CD0) and Oswalds efficiency (e) of an aircraft from experimental data obtained during steady and level flight, Climb Performance - Introduction, Equations of Motion and Flight test for steady climb.

Stability and Control - Fundamental concepts of stability, Stability and Control - Discussion on Equilibrium, Static and Dynamic Stability, Stability and Control - Discussion on Center of Pressure, Aerodynamic Center and Trim, Static Stability - Wing contribution, Tail contribution and Static Margin, Static Stability and Control - Elevator Control power, Elevator Angle to trim and Flight test to estimate Stick Fixed Neutral Point, Stick Free Stability and Control, Static Free Stability and Control - Stick free Neutral Point, Stick force, Flight test to estimate Stick free neutral Point.

Maneuvering Flight: Introduction, Steady Coordinated turn, Maneuvering Flight: Steady Pull up, Relationship between stick fixed Neutral and Maneuvering point, Maneuvering Flight: Stick Fixed Maneuvering point and Flight test to estimate stick fixed Maneuvering point, Maneuvering Flight: Stick free maneuvering point, Stick force Gradient and Flight test to estimate Stick free Maneuvering point, Lateral and Directional Aerodynamic Model, Directional Stability and Control, Lateral Stability and Control

Various Coordinate System, Conservation of Linear Momentum Equation, Conservation of Angular Momentum Equation, Euler Angles, Kinematic Equations, Flight Path Equations, Gravity Equations and Combined 6-DOF model

Flight Experiment: Instruments used in flight test, Flight Experiment: Cruise and climb performance, Flight Experiment: Flight tests to estimate stick free and fixed, neutral and maneuvering points, Static Lateral and Directional Stability: Flight Test to estimate Side-Slip Coefficient ($Cy\beta$), Flight Test to estimate yawing Moment Coefficient ($Cn\beta$), Flight Test to estimate Roll Derivative ($Cl\beta$), Static Lateral and Directional Stability: Steady

Coordinated turn, Flight Test to estimate Roll Derivative (Clr), Flight Test to estimate Yawing Moment Coefficient (Cnr), Phugoid Effect and Dutch Roll Motion

Learning outcomes :

Will learn the influence of atmosphere, airplane weight and airplane configuration on aircraft performance. Will learn airplane performance limitations such as airspeed, load factor.
Calculate and analyze Airspeed-Drag curve.
Calculate fuel consumption, flight range and endurance of an airplane.
Calculate take-off and landing distances.
Will understand the effects of airplane performance on air traffic management system

Book referenced:

INTRODUCTION TO FLIGHT- JOHN D Anderson
Flight Stability and Automatic control R C NELSON

8. ASE 008 – Microproessors and Software Engineering

The CPU : CPU register, ALU Control Unit, status, flags, introduction, execution, instruction, timing diagrams, instruction cycles, microprogamming and the control unit, chip slice units.

Logic beyond the CPU - Interfacing programs and data. Memory program i/o interrupt, error detection, various protocols, synchronous serial data transfer, programmable control/ timers. Real time clock, logic distribution among microcomputer devices.

Programming microcomputer, review of programming language, source program, object program, assembly language, memory addressing, the stack indirect addressing, indexed addressing, base relative addressing, memory segmentation., Introduction to set a - CPU architecture. A description of instructions, advanced microprocessor instruction set concepts.

Boolean algebra, postulates and theorems, standard forms, formulation of switching functions, simplification of Boolean expressions. Basic building block, realization of switching function using NAND and NOR gates. Flip flops, counters and shift registers.

Introduction to computers, computer characteristics, types of programming languages. Introduction to BASIC, fundamental concepts of BASIC language such as numbers, variables and formulas. BASIC statements, BASIC programs, branching and looping, additional features of BASIC.

Advanced BASIC, functions and sub-routines, vectors and materials, data files, introduction to micro computer BASIC.

Programming using Fortran IV, Fortran statement constants and variables, arithmetic operation and expressions, logical constants and operations, logical expressions, rading and printing formats, control and decision statements, GO TO statement, IF statement, DO loop - DO statement, continue statement. Multi-dimensional arrays and nested DO loops, library functions, sub-routines and simple FORTRAN programmers, Computer Languages such as C and C+.

‡ Central Maintenance Computer Systems
‡ Data Loading Systems
‡ Electronic Library Systems

Text Books :

1. A P Mathur, Introduction to Microprocessors, Tata McGraw Hill
2. P D Choudhari, Computer Organization and Design, Prentice Hall
3. Glenn A Gibson, Microcomputer Systems, Prentice Hall

Reference Books :

1. C W Gear, Computer Organisation and Programming
2. Rajaram V, Computer Programming in Fortran IV, Prentice Hall

9. E16010796 – Integrated Flight Instrument System

Gyroscopes: development of the gyroscope and its properties; drift and transport wander; practical gyroscopes; pneumatic, vacuum and electrically driven gyros; errors and limitations

Flight instrument applications: direction indication (eg the horizontal axis gyroscope); artificial horizons (eg principle of the gyro horizon, use as standby attitude indictors); turn and bank indication (eg for turn rate detection and bank and slip indication); erection and leveling methods; error sources and control

Terrestrial magnetism*:* nature of magnetism; variation; dip; direct reading compasses; compass construction; location considerations; errors and dynamic behaviour; analysis of deviation and compensation

Remote indicating compass/magnetic heading reference system (MHRS): principles of synchronous data transmission and synchro types; flux valves; the directional gyro unit and its

application as a directional reference; system operating modes; deviation compensation; integration with radio and inertial systems

Features of the atmosphere: layers of the atmosphere (eg ionosphere, troposphere) and their effects on pressure and temperature

Air data measurement: horizontal speed measurement (eg pitot systems and engineering considerations, direct and indirect systems, airspeed indication and terms, mach meters); altitude measurement (eg principle of the barometric altimeter, pressure settings); vertical speed measurement (eg principle of differential pressure measurement); air temperature measurement (eg total air temperature, static air temperature); construction; types of sensor; indicators; integration into other systems; error sources

Air data computers: advantages of integrating air data; analogue and digital methods of air data computation; utilisation of computed data; alerting and warning requirements; applications

Flight director systems: use of the vertical gyro; systems inputs; computation; Attitude Director Indicators (ADI); Horizontal Situation Indicator (HSI); interface to other aircraft systems; typical aircraft control panels and mode selectors

Electronic displays: cathode ray tube displays; alphanumeric displays; Liquid Crystal Displays (LCDs); symbol generation; ambient light sensors

Electronic flight instrument systems: Electronic Attitude Director Indicator (EADI); Electronic Horizontal Situational Indicator (EHSI); system inputs; typical displays; failure and reliability considerations; aircraft case study

Learning outcomes:
List various electronic instrument systems and avionics systems integration for the design of modem aircraft.
CO 2 Illustrate the fundamental principles of various types of sensors to monitor the parameters in an aircraft.

CO 3 Illustrate the working principles of various flight instruments in flight deck for monitoring status of the flight in one integrated display.
CO 4 Explain the basic principle and various types of navigation systems to provide accurate position of a moving aircraft relative to earth.
CO 5 Explain the concept of various navigational aids that guide the pilot to land the aircraft safely on a runway.
CO 6 Demonstrate the major methods of countering detection and impairing the effectiveness of an enemy's fire control solution
CO 7 Identify Hardware MODULEs, working principle, Environmental effects and applications of Airborne Radar for detect the enemy aircraft.
CO 8 Explain the optical attitude measuring instruments for monitored throughout its on-orbit operation

Book referenced

Aircraft instrument -E H J Pallett
Instrumentation and control system- K Padmaraju

10. E16010785 – Engineering Science

Simply supported beams: determination of shear force; bending moment and stress due to bending; radius of curvature in simply supported beams subjected to concentrated and uniformly distributed loads; eccentric loading of columns; stress distribution; middle third rule

Beams and columns: elastic section modulus for beams; standard section tables for rolled steel beams; selection of standard sections (eg slenderness ratio for compression members, standard section and allowable stress tables for rolled steel columns, selection of standard sections)

Torsion in circular shafts: theory of torsion and its assumptions (eg determination of shear tress, shear strain, shear modulus); distribution of shear stress and angle of twist in solid and hollow circular section shafts

Uniform acceleration: linear and angular acceleration; Newton's laws of motion; mass moment of inertia and radius of gyration of rotating components; combined linear and angular motion; effects of friction

Energy transfer: gravitational potential energy; linear and angular kinetic energy; strain energy; principle of conservation of energy; work-energy transfer in systems with combine linear and angular motion; effects of impact loading

Oscillating mechanical systems: simple harmonic motion; linear and transverse systems; qualitative description of the effects of forcing and damping

DC electrical principles: Ohm's and Kirchoff's laws; voltage and current dividers; analogue and digital signals; review of motor and generator principles; fundamental relationships (eg resistance, inductance, capacitance; series C-R circuit, time constant, charge and discharge curves of capacitors, L-R circuits)

AC circuits: features of AC sinusoidal wave form for voltages and currents; explanation of how other more complex wave forms are produced from sinusoidal wave forms; R, L, C circuits (eg reactance of R, L and C components, equivalent impedance and admittance for R-L and R-C circuits); high or low pass filters; power factor; true and apparent power; resonance for circuits containing a coil and capacitor connected either in series or parallel; resonant frequency; Q-factor of resonant circuit

Transformers: high and low frequency; transformation ratio; current transformation; unloaded transformer; input impedance; maximum power transfer; transformer losses

Information systems: block diagram representation of a typical information system (eg audio communication, instrumentation, process monitoring); qualitative description of how electrical signals convey system information; function, operation and interfacing of information system components (eg transducers, transducer output and accuracy, amplifier types, typical gain, resolution of analogue to digital and digital to analogue converters, types of oscillators and operating frequencies); effect of noise on a system; determination of system output for a given input

Energy flow control systems: block diagram representation of an energy flow control system (eg AC electric drives, DC electric drives, heating, lighting, air conditioning); qualitative description of how electrical signals control energy flow; function, operation and interfacing of energy flow control system components (eg transistor, thyristor, temperature-sensing devices, humidity sensing devices, speed control elements for DC and AC machines, dimmer devices and relays); determination of system output for a given input; selection and interfacing of appropriate energy flow control system components to perform a specified operation

Interface system components: identification of appropriate information sources; select and interface information system components or select and interface energy flow control system components, to enable that system to perform desired operation

Learning Outcomes:

Understand the concepts of stress and strain at a point as well as the stress-strain relationships for homogenous, isotropic materials.

Calculate the stresses and strains in axially-loaded members, circular torsion members, and members subject to flexural loadings.

Calculate the stresses and strains associated with thin-wall spherical and cylindrical pressure vessels.

Book referenced

BTEC Higher national- Pearson

Strength of material - Dr. RK Bansal

11. E16010790– Thermodynamics and Fluid Mechanics

***Fundamental Concepts and Definitions*: ** Scope and limitations of thermodynamics. Thermodynamic system, state, property, change of state, thermodynamic equilibrium, path process, cycle density, pressure and their molecular interpretation - dimension and units - Zeroth law of thermodynamics and concept of temperature, temperature scales, work and heat definition and units of work and heat, work of frictionless process, PV diagram, indicator diagram.

***First law of Thermodynamics*:** Statement of the first law. Energy. Internal energy and its microscopic interpretation, enthalpy, applications of first law.

Steady Flow Energy Equation (SFEE). The steady - state, steady -flow process. The Joule-Thomson coefficient and the throttling process. Uniform state, Uniform flow process, SFEE and its applications.

***Second Law of Thermodynamics*:** Limitations of the first law, heat engines, reversed heat engines and their performance, Kevlin-Planck's and Clausius statements of the second law reversibility-reversible and irreversible processes: Carnot cycle thermodynamic temperature scale: Clausius-Clapeyron equation.

***Entropy*:** The property, entropy, principle of increase of entropy, calculation of entropy changes, T -S and h-s diagrams. Microscopic interpretation of entropy-Helmholtz (A) and Gibbs (G) functions.

***Physical properties*:** Pure substance definition-internal energy and enthalpy of a pure substance, specific heats, equilibrium of phases, phase diagrams, phase changes, critical state, PVT surface, tabulated properties and process calculations. Maxwell relations.

***Ideal and Real Gases*:** Definition-internal energy and enthalpy, specific heats and their calculation from simple kinetic theory, gas tables, Van dcr Waal's equation of state, principle of corresponding states, compressibility factor.

***Vapour Power Cycles*:** Carnot cycle using steam, Rankine cycle, reheat cycle, binary vapour cycles.

***Air Standard Power Cycles*:** Carnot cycle, Otto cycle, Diesel cycle, dual cycle, gas turbine cycles, inter cooling, reheating and regeneration, gas turbine jet propulsion, deviation from ideal cycles.

Learning outcomes:
Describe basic concepts of Thermodynamics.
Restate definition of system, surrounding, closed and open system, extensive and intensive properties.
Calculate absolute and gage pressure, and absolute temperature.
Calculate changes in kinetic, potential, enthalpy and internal energy

Book referenced
Thermodynamics -Yunus A Cengel
Engineering thermodynamics- PK Nag

12. HND 112 - Aircraft Structural Integrity

Fracture strength: significance of fracture mechanics; strength; toughness; critical crack length; Griffith energy balance approach; Irwin's theory; stress intensity approach; crack tip plasticity; fracture toughness; critical crack growth

Fatigue and creep: the nature of fatigue; fatigue effects; sources of fatigue (eg cyclic, thermal, acoustic, sonic, fretting and corrosion fatigue); fatigue strength; S-N curves; endurance limit; determination of fatigue life; fatigue testing; creep (eg characteristics, stages, creep rate and rupture times, kinetic heating and creep)

Design methods: design philosophy; safe-life and fail-safe structures

Crack growth: nature of fatigue crack growth and stress intensity factors; prediction of fatigue crack growth under constant amplitude loading; environmental effects

Fracture mechanisms: study of fracture surfaces; slip; plastic deformation and dislocations; ductile trans granular fracture by micro void coalescence; brittle trans granular fracture (cleavage); trans granular and intergranular fracture by fatigue; the effects of fracture path and microstructure; material behavior and mechanisms of fracture

Micromechanics and properties: mechanical properties of unidirectional composites (e.g. longitudinal stiffness and tensile strength, transverse stiffness and strength); fiber volume fraction and the equation of mixtures; off-axis stiffness and strength; properties of cross-ply and angle-ply laminates; discontinuous fiber laminates; the use of fiber composite materials in aircraft structures

Adhesion and surface treatments: analysis of bonded v rivet repairs; adhesives; adhesion and adhesive testing; surface preparation; surface treatments (eg structural aluminum alloys, titanium alloys, phosphoric acid anodizing, chromic acid anodizing)

Metal bonded repairs: thin sheet metal construction (eg sheet thickness criteria, overlap lengths, material specification, strength considerations); residual strength of flawed or damaged adhesive bonded joints; acceptable criteria for bond flaws and damage; life prediction for adhesively bonded joints

Composite bonded repairs: repair materials; composite repair concepts and methods (eg bolted repairs, bonded repair categorization (non-structural, secondary structural and primary structural), non-patch repairs, bonded external patch, scarf and flush repairs); effects of moisture on bonded repair of composites; design of bonded repairs (eg general considerations, external patch design, laminate design)

Damage assessment: structures and structural components (eg use of equipment to assess general damage, nature and identification of types of corrosion); non-destructive evaluation (NDE) of structures (eg using optical, penetrate dye, ultrasonic, radiographic, eddy current, acoustic emission and thermography techniques)

Policy and procedures: corrosion damage prevention methods (eg detail design, protective coatings, inhibitors, anodic protection, materials selection and treatment); repair policy (eg downtime considerations, costs, repair by replacement, repair and rectification organization); quality assurance procedures; out sourcing; repair procedures for metal and polymer matrix composites (PMC) structures and components; repair materials handling, storage and procurement; field repair considerations (eg simple techniques, limited use of repair equipment, first-aid repair techniques, availability of cure facilities)

Integrity of aircraft structures: inspection procedures (eg nature and frequency of inspection, structural component access and component life considerations); condition monitored maintenance (eg hard-time, on-condition and condition monitoring and their relationship to aircraft structure); statistical information sources and corresponding reliability techniques; data collection and structural component history; maintenance reporting procedures; corrective action methodology and quality assurance procedures; SBAC, Civil Aviation Authority (CAA) and Military regulations for the manufacture and maintenance of aircraft structures and structural components; temporary repairs.

Learning Outcomes:

1. Investigate failure mechanism in aircraft structures.
2. Design and analyses bonded repairs for both metal and composite structures.
3. Devise and manage productions schedules or preventative maintenance programs.

Book Referenced:

Megson THG, Aircraft structures for engineering learners.

13. E16010782 – Aircraft System Theory

Aircraft systems: system definition; system state and operating environment; basic electromechanical system components (eg sensor/transducer, comparator (error detector), signal conditioner and actuation device); G notation; feedback signals; H notation; simple system transfer functions

Transducers: characteristics; operation and applications — optical (eg photoconductive cell, photovoltic, photodiode, phototransistor); magnetic (eg induction, reluctance, hall-effect); heat (eg thermocouple, thermistor, radiation pyrometer); electro-mechanical (limit switches); other (eg potentiometers, strain gauges, differential transformers, tacho-generators, pressure sensors, gauges (flow meters), incremental and absolute encoders)

Signal conditioning and amplifiers: physical signals; digital and analogue signals; digital to analogue (DAC) and analogue to digital (ADC) converters; signal frequency and amplitude; error signal modification and amplification; open and closed loop control signal paths; introduction to feed-forward signals; mechanical amplifiers and signal conditioners; electrical amplifiers and comparators; active filters

Power generation: comparison of aircraft pneumatic, hydraulic and electrical power generation (eg advantages and disadvantages, circuit operation, power distribution, alternative power supplies)

Safety of aircraft power distribution: primary and secondary systems; standby and emergency provision; circuit and system components; duplication and failsafe philosophy

Power actuation systems: principles; constructional detail; control and protection methods; comparison of fluid and electrical power actuation methods and systems (eg fluid motors and actuators (single, double acting, rotary, linear, reciprocating piston, spur gear), electric motors

and actuators (eg alternating current (AC) and direct current (DC) motors, induction, synchronous, stepper motor, multi-phase cage motor), linear and rotary actuators)

Performance parameters: aircraft applications; high and fractional horsepower; fluid and electrically driven motors and actuators; parameters for DC applications (eg speed, torque, on and off load characteristics); parameters for AC applications (eg speed of rotation related to applied voltage, power available on constant rated applications)

Remote position control systems: applications (eg guide vane control of missile, radar aerial movement, positioning of aircraft control surfaces, autopilot platform displacement, gyro compass platform positioning, inertial navigator platform stabilization, nose wheel steering system, engine speed control, engine pressure ratio signaling and control, engine speed and temperature control, generator frequency and voltage control, hydraulic servo rate and positioning control, electric motor positioning and control, cabin temperature control, engine fuel control)

Response of control systems: step and ramp inputs; transient and steady state response; stability of response; overshoot and hunting

Damping methods: damping terms and definitions; Coulomb and viscous friction damping; electrical damping; velocity feedback damping; damping methods used in aircraft systems

System control methods: proportional and derivative control; proportional and integrative control; analogue/digital hybrid control; system response to control methods

Servomechanism control systems: control system definitions; open and closed loop control systems; servo-mechanism motion control; rate and position sensing and control Synchro; remote positioning control (RPC) systems.

Book referenced:

Aircraft design -wiley
Aircraft engineering principles- Lloyd Bingley and Mike tooley

14. E16010783 – Aircraft Fluid Mechanics

Introduction: Fluids: Definition of fluids, the science of fluid mechanics, fluid properties, capilliarity, surface tension, compressibility, units and dimensions. Normal and Shear stresses in fluid flows, measurement of fluid velocity.

Regimes of fluid flows: Continuum and free molecular flow, inviscid and viscous flows, incompressible and compressible flows, Newtonian and Non-Newtonian flow, Aerodynamic force and moments, Dimensional analysis, Non-dimensional parameters, M, Re, Fr etc.

Fluid Statistics: Pascal's law, types of forces on a fluid system, measurement of pressure, use of manometers and gauges, numerical problems. Hydraulic devices, forces on partially and fully submerged bodies, including that on curved surfaces, numerical problems, buoyancy, stability of floating bodies, centre of gravity and meta centric heights.

Description of Fluid Motion: Lagrangian and Eulerian methods, description of properties in a moving fluid, local and material rate of change, equation of conservation of mass for control volume. Streamlines, path lines, streak lines, vorticity and circulation, laws of vertex motion, translation, rotation and rate of deformation of fluid particle.

Equations of Fluid Motion: Euler's and Navier stokes equation, derivation of Bernoulli's equation for inviscid and viscous flow fields momentum equation and angular momentum equation in Integral form.

Inviscid - Incompressible Flow: Condition on velocity for incompressible flow, Laplace's equation, potential function, stream function. Basic elementary flows: uniform flows, source flows, doublet flow and vortex flow. Super -imposition of elementary flows, non lifting and lifting flow over a circular cylinder. Pressure distribution over circular cylinder in real flow. Kutta - Juokowaski Theorem, Generation of lift. Lift on air foils.

Introduction to Viscous Flows: Qualitative aspects of viscous flows, viscosity and thermal conductivity, phenomenon of separation, Navier stoke's equations in vector form, viscous flow energy equation, some exact solutions of Navier stoke's equations: Plane poisuille flow, Couette flow, Hagen - Poisuelle flow, Hele - Shaw flow, flow through co- rotating cylinders. Transition from laminar to turbulent flow. Turbulent flow in circular pipe.

Introduction to Incompressible Boundary layer (BL): BL Concept, BL Properties, derivation of Prandtl's BL Equation, Blasius solution, Karman's Integral equation, Turbulent BL over a flat plate, skin friction drag, BL Control.

Dimensional Analysis and Similitude: Buckingham's theorem, non-dimensional groups, Geometric, Kinematic and Dynamic similarity, Applications.

Elements of Compressible Flows: Compressible flow properties, total Enthalpy, total temperature, temperature and pressure ratio as function of mach number. Mass flow parameter (MFP), Isentropic area ratio A/A*, velocity - area variation, 2-D small amplitude wave propagation, Adiabatic Steady Flow Ellipse. Description of flow regimes, Introduction to Normal and Oblique shock waves, working out solutions through Gas Tables/Charts

Learning outcomes:

Calculate the pressure distribution for incompressible fluids.

Calculate the hydrostatic pressure and force on plane and curved surfaces.

Demonstrate the application point of hydrostatic forces on plane and curved surfaces.
Formulate the problems on buoyancy and solve them

Book referenced:

Fluid mechanics- yunus A cengel
Fluids mechanics and Hydraulic machines- Dr. Rk bansal

15.HND 109 - Programmable Logic Controllers

The PLC in Automation Systems, The PLC Versus the Microcomputer, Ladder Logic Programming, Controlling Pneumatic and Hydraulic Systems, Safety, Networking of PLCs.

The *z*-Transform: Representation of Discretely Sampled Data, The z-Transform of a Closed-Loop System, Proportional Control Using Digital Techniques, The z-Transform for a PID Controller, A P + I Strategy Using Digital Techniques, Stability in Discrete Time Systems.

State Variable Techniques: State Variable Representation of Systems, Application to a First-Order System with A P + I Controller, Application to a Second-Order System with A P + I Controller, Nonlinear System Elements (Method of Isoclines), Sampled-Data Systems, State Variable Transformations, The State of Transition Matrix.

Learning Outcomes:

1. Understand the design and operational characteristics of a PLC system
2. Understand PLC information and communication techniques
3. Be able to apply programmable logic programming techniques
4. Understand alternative implementations of programmable control.

Book referenced

Programmable logic controller- W. Bolton
Programmable logic controller – JR hackworth

16. E16010791 – Aircraft Gas Turbine Science

***Measurement of fluid flow*:** instrumentation (eg manometers, bourdon gauge, pressure transducers, micro-manometers); forces on curved surfaces; continuity equation; energy of a moving fluid; venturi meter; pitot tube

***Velocity diagrams and power*:** velocity and pressure distribution in nozzles; air velocity change through blade rows; forces acting on blades; power requirements for compressor and turbine stages

***Aerodynamic losses*:** losses in axial compressors and turbines; jet and propeller propulsion; flow-through turbines; fans; compressors; primary and secondary losses; operating characteristics and surge; losses due to sudden enlargement and contraction in turbulent flow

***First law of thermodynamics*:** non-flow energy equation; reversibility; displacement work transfer; reversible non-flow processes; relationship of perfect gases; application of non-flow energy equation; steady flow energy equation; continuity equation; application of steady-flow energy equation

***Second law of thermodynamics*:** ideal heat engine and reversed heat engine; ideal heat engine cycle; entropy changes in adiabatic processes; isentropic efficiency; processes on T-S diagram; entropy changes for perfect gases

***Gas turbine cycle*:** gas turbine cycle with isentropic efficiency; velocity diagrams and power calculations

***Air intakes*:** design considerations of duct rating; types of intake; ideal airflow behaviour; shock waves; variable geometry intakes; supersonic intakes; flow through intake under static; climbing and high-speed conditions; asymmetrical intakes; area ratio; flow matching; loss characteristics; performance parameters; methods of diffusion; aerodynamic considerations for design of subsonic high-bypass fan; throat sizing; lip sizing; diffuser design; external cowl design

***Compressors*:** degree of reaction and effects; blade design; compressor stage power requirements; work done factor; flow coefficient; stage temperature rise coefficient; surge at various operating conditions (mapping) and surge control; blade flutter; calculations for a stage

***Combustion chambers*:** design features of combustion chambers; gas turbine combustion (eg diffusion, combustion, fuel injection, dilution); diffuser performance and stability loop; dilution zone performance; dilution zone mixing performance; losses due to dissociation; combustion system pressure losses; temperature distribution; combustion efficiency; derivation of pressure loss equation

***Flame stabilization*:** definition of stability performance; measurement of stability performance; experimental data on stability; factors controlling stability; fuel type; fuel-air-ratio; velocity; temperature; pressure; flame holder size and shape

<u>Turbines</u>**<u>:</u>** performance characteristics for a single stage; type of turbine stage; blade design; stage loading coefficient (eg flow coefficient characteristics); non-dimensional blade speed; non dimensional temperature drop (eg flow velocity characteristics, reaction)

<u>Pressure ratio</u>**<u>:</u>** non-dimensional mass flow characteristics; pressure ratio; non-dimensional mass flow; reaction; design charts; metallurgical requirements; problems associated with turbines; forms and types of cooling; effects of reaction; blade loading; flow coefficient; stage loading coefficient; efficiency contours for single stage turbines; data for axial-flow gas turbine calculation

Book referenced

Gas turbine- V Ganesan

Gas turbine theory- Pearson

17. E16010787 – Aircraft Propulsion Technology

Gas turbine science: Newton's laws; momentum; inertia; thrust; mechanics of reaction propulsion; nozzles and ducts; gas laws (eg Boyles Law)

Working cycles of gas turbine and piston engines: brayton cycle; velocity; temperature; pressure; propulsive efficiency; piston engine fundamentals and indication systems

Gas turbine and piston engine systems: turbo-prop; turbo-jet; high and low by-pass; 2 and 4 stroke engines

Performance data: power and thrust to weight ratio; engine dimensions; specific fuel consumption; engine rpm; effects of compressor bleed; nozzle areas; inlet temperatures; drag and ram pressure rise

Graphical methods: performance graphs and charts

Modules of a gas turbine engine: intakes (eg requirements for subsonic and supersonic intakes and intake design, effect of internal and external geometry on boundary layer and ram recovery, variable flight conditions, engine failure protection, high bypass engines, ice protection); compressors (eg centrifugal, axial, multi-spool, transonic, performance, stalling, surging, interaction between mechanical and aerodynamic design, in-service problems); combustion chambers (eg design criteria, typical combustion and ignition systems, types of burners); turbines (eg turbine geometry, blade cooling, design and aerodynamic performance of blades, nozzle guide vanes, related calculations, mechanical design of discs, blade attachment in relation to aerodynamic requirements, blade materials, vibration, root stresses, fatigue, creep); exhaust (eg function and design of jet pipe nozzle, control and direction, gas flow velocity, construction and operation of reverse thrust, after burners, noise reduction)

Maintenance activities: engine condition inspections; blade clearance checks; assessment of internal damage; fuel, lubricant and fluid system checks; pre-flight checks; controls inspections; ground running

Propeller aerodynamics: thrust; torque; lift and drag; blade angle; angle of attack; blade twisting; forces along blade; propeller efficiency; type (eg fixed, two pitch, constant speed and variable pitch propellers); windmilling; reverse pitch; aerodynamic and centrifugal turning moments

Propeller control: pitch change mechanism; control units (eg propeller governor, unfeathering accumulators, pitch control mechanism); operation; feathering system; pitch locks and beta control; synchronising

Performance parameters: design applications and performance parameters for turbo-prop, turbojet and turbo-fan; engine airflow graphs; choked nozzles; mechanical forces; thrust calculations and thrust load paths; dependent and independent accessories (gross, net, choked nozzle, thrust); thrust HP, ESHP

Material limitations: power rating; centripetal forces; temperatures

Engine performance monitoring: instrumentation (eg temperature and power output); thermocouple position; exhaust gas temperature (EGT) and jet pipe temperatures (JPT);

thrust and rotational speed; engine pressure ratio and integrated engine pressure ratio; data analysis and performance trend monitoring

Engine condition monitoring: vibration; lubrication systems; FADEC systems

Engine construction: crankcase; crankshaft; sumps; accessory gearbox; cylinder and piston assemblies; valve mechanism and timing; propeller reduction gearboxes

Fuel, lubrication and ignition systems: carburettors; fuel injection; starting and ignition; exhaust and cooling; supercharging/turbo-charging; lubrication; operation; layout and components; FADEC

Power plant installation: configuration of firewalls; cowlings; acoustic panels; engine mounts; anti-vibration mounts; control systems

Engine monitoring and ground operation: starting and ground run-up; engine power output and parameters; engine inspection and maintenance

Book referenced

Elements of Gas turbine propulsion- Jack .D Mattingly
Aircraft Gas turbine PowerPlants – Charles E Otis

18. Manufacturing Process

Component manufacture: specify components for manufacture
Machining techniques: production of flat and cylindrical geometry
Tooling requirements: multi-tooth cutting\ Work-holding techniques: selection of appropriate work-holding devices
Component manufacture: specify components for molding and shaping
Molding processes: casting eg sand, die, investment and continuous casting; powder metallurgy; sintering
Metallic materials: range applicable to component eg ferrous, non-ferrous, alloys
Ceramic materials: range applicable to component
Material properties: changes to the molecular structure and hence the material properties that may arise from a molding or shaping operation eg grain growth, work hardening, cracking, orientation of grain flow
Component manufacture: principle of operation of the less-conventional machining techniques eg electro-discharge machining (EDM), wire erosion, ultrasonic machining, etching of electronic printed circuit boards (PCBs), laser-beam machining, plasma-jet machining; specification of components for less-conventional machining techniques eg criteria-tolerances, types of material, suitable technique, surface texture, material removal rate, cost factors.

Learning Outcome:

1. Select suitable conventional machining processes and techniques for generating geometrical forms for a given component specifications.
2. Select suitable molding and shaping process for given component specification.
3. Select suitable non-conventional machining techniques for given component specifications.

Book Referenced:

KalpakJian S, Manufacturing Engineering and Technology.

20. HND 101 - Business Management Techniques for Engineers

1 Be able to prepare a design specification to meet customer requirements
Customer requirements: all relevant details of customer requirements are identified and listed eg aesthetics, functions, performance, sustainability, cost, timing and production parameters; all relevant regulations, standards and guidelines are identified and listed eg international, national, company policy and procedures, industry specific, statutory bodies Design parameters: implications of specification parameters and resource requirements are identified and matched; the level of risk associated with each significant parameter is established Design information: all relevant information is extracted from appropriate reference sources; techniques and technologies used in similar products or processes are identified; use of new technologies are specified where appropriate; relevant standards and legislation are identified and applied throughout; design specification is checked against customer requirements

2 Be able to analyse and evaluate possible design solutions and prepare a final design report
Analysis of possible design solutions: selection and use of appropriate analysis techniques to achieve a design solution eg matrix analysis, brainstorming, mind mapping, forced decision making, simulation Evaluation of conceptual designs: costs; future development potential; value engineering concepts Compliance check: eg using checklists and/or design review procedures Final design report: communicate rationale for adopting proposed solution; use of appropriate techniques and media in the presentation of the report eg sketches, charts, graphs, drawings, spreadsheets/databases, computer aided design (CAD), desk top publishing (DTP), word-processing

3 Understand how computer-based technology is used in the engineering design process.
Key features of computer-aided design systems: 2D design and 3D modelling systems eg accessing standards, parts and material storage and retrieval, engineering calculations, PCB layouts, integrated circuit design, circuit and logic simulation (including ac, dc and transient analysis, schematic capture) CAD software: accessing and using appropriate design software eg parts assembly, pipework and ducting layouts, networks, planned maintenance, scheduling, planning, stress andstrain, heat transfer, vibration analysis, resource utilisation, plant layout, costing, circuit emulation, plant electrical services, for example, finite element analysis and printed-circuit board analysis software Software evaluation: consideration of costs, compatibility and function

Learning Outcomes:

1. Manage work activities to achieve organisational objectives.
2. Select and apply costing system and techniques.
3. Analyse the key functions of financial planning and control.
4. Apply project planning and scheduling methods to a specified projects.

Book Referenced:

O.P. Khanna, Industrial Engineering.

21.E16010794 – Orbital Mechanics

Dynamics of point masses: Introduction; Kinematics; Mass, force and Newton's law of gravitation; Newton's law of motion; Time derivatives of moving vectors; Relative motion

The two-body problem: Introduction; Equations of motion in an inertial frame; Equations of relative motion; Angular momentum and the orbit formulas; The energy law; Circular orbits ($e = 0$); Elliptical orbits ($0 < e < 1$); Parabolic trajectories ($e = 1$); Hyperbolic trajectories ($e > 1$); Perifocal frame; The Lagrange coefficients; Restricted three-body problem

Orbital position as a function of time: Introduction; Time since periapsis Circular orbits; Elliptical orbits; Parabolic trajectories; Hyperbolic trajectories; Universal variables

Orbits in three dimensions: Introduction; Geocentric right ascension–declination frame; State vector and the geocentric equatorial frame; Orbital elements and the state vector; Coordinate transformation; Transformation between geocentric equatorial and perifocal frames; Effects of the earth's oblateness

Preliminary orbit determination: Introduction; Gibbs' method of orbit determination from three; position vectors; Lambert's problem; Sidereal time; Topocentric coordinate system; Topocentric equatorial coordinate system; Topocentric horizon coordinate system; Orbit determination from angle and range; measurements; Angles-only preliminary orbit determination; Gauss's method of preliminary orbit determination

Orbital maneuver: Introduction; Impulsive maneuvers; Hohmann transfer Bi-elliptic Hohmann transfer; Phasing maneuvers; Non-Hohmann transfers with a common apse line; Apse line rotation; Chase maneuvers; Plane change maneuvers

Relative motion and rendezvous: Introduction; Relative motion in orbit; Linearization of the equations of relative motion in orbit; Clohessy–Wiltshire equations; Two-impulse rendezvous maneuvers; Relative motion in close-proximity circular orbits

Interplanetary trajectories: Introduction; Interplanetary Hohmann transfers; Rendezvous opportunities; Sphere of influence; Method of patched conics; Planetary departure; Sensitivity analysis; Planetary rendezvous; Planetary flyby; Planetary ephemeris; Non-Hohmann interplanetary trajectories

Rigid-body dynamics: Introduction; Kinematics; Equations of translational motion; Equations of rotational motion; Moments of inertia; Parallel axis theorem; Euler's equations; Kinetic energy; The spinning top; Euler angles; Yaw, pitch and roll angles

Satellite attitude dynamics: Introduction; Torque-free motion; Stability of torque-free motion; Dual-spin spacecraft; Nutation damper; Coning maneuver; Attitude control thrusters; Yo-yo despin mechanism; Gyroscopic attitude control; Gravity-gradient stabilization

Rocket vehicle dynamics: Introduction; Equations of motion; The thrust equation; Rocket performance; Restricted staging in field-free space; Optimal staging; Lagrange multiplier

Book referred

Orbital mechanics for engineering students by Howard Curtis

22. E16010792– Aircraft Material

<u>Engineering Materials,</u> Structural properties of materials, Atomic and lattice structure, Bonding in Solids, Imperfections in crystals, Solid phase and phase diagrams, mechanical properties and testing, Isotropy, Orthotropy, True stress and strain, Strength and elasticity, Stiffness, Resistance,

Plasticity, Ductility, Toughness and Hardness of materials. Concept of Fatigue and Creep. **<u>Mechanical Testing.</u>** Factors Affecting Strength. Deformation, Plasticity and Viscoelasticity, Fracture. Heat treatment, Chemical, thermal and Technological Properties, Board classification of aircraft materials. Ferrous materials, nonferrous materials and alloys, ceramic materials and fibre reinforced composite materials, polymers, metal matrix particulate.

***<u>Furnishing Materials</u>*:** Plastic, wood, plywood, glue, dopes and rubber used in aircraft manufacture. Methods of testing and storage. Paints, surface finishes and materials. **<u>Specifications:</u>** Indian Standard, British, American, French, German, and International specifications.

<u>Corrosion, its detection and prevention.</u> Protective finishes. Testing: Destructive and non-destructive testing techniques. Crack detection, inspection of parts by hot oil and chalk, dye-penetrant, fluorescent and magnetic particles, X-ray, ultrasonic, eddy current and acoustic emission methods.

Book referenced

Aircraft materials and processes- G.F Tittertol
Materials and hardwares- EASA

23. E16010798 – Rocket Electronics

Circuits and testing: half and full wave rectifying; zener regulator; switching and amplifier circuits for transistors; IC voltage regulators instruments eg CRO, probes, signal generators, multi-meter, logic

Devices: semiconductor devices eg diodes (rectifier characteristics including forward/reverse bias modes, zener, LED, photodiode, thyristor, triac), transistors (bipolar, unipolar and fieldeffect, including characteristics and switch and amplifier modes), photo-transistors, optocouplers, integrated circuits (741 operational amplifier applications including filters, comparators, power supplies and oscillators), IC voltage regulator, 'specialist' ICs (analogue and digital)

Literature: manufacturers' specifications; manuals; characteristics; circuit diagrams and support (online and offline)

Amplifier characteristics: ideal (gain, bandwidth, input/output impedance, noise, thermal drift); common notation; DC/AC behaviour; op-amp basic circuits; limitations (DC, AC, nonlinear, power); common applications; internal circuitry of 741 (differential, voltage and output amplifier)

Analyse operation and performance: use of quantitative methods; equivalent circuits; computer modelling; consideration of frequency response; voltage gain; bandwidth; output power; distortion; input and output impedance

Types and benefits of amplifier: power eg single-ended Class A, complementary symmetrical Class B, Class AB; tuned; small-signal; operational amplifiers eg inverting, non-inverting, voltage follower, differential, summing, integrator, differentiator, comparator, instrumentation, Schmitt trigger; active filters (high-pass, low-pass, band (pass, reject), notch)

Modify circuit designs: using manufacturers' data; circuit calculations; to meet revised specifications using alternative components to achieve lower cost or to improve performance

Types and effects of feedback: types eg voltage, current, series, shunt; effects eg closed loop gain of a system with feedback, feedback in single and multi-stage circuits

Circuit performance: effect of feedback on gain, bandwidth, distortion, noise, gain stability, input and output impedance

Circuits: single-stage transistor amplifier; operational amplifier

Investigate: circuit design and build, practical measurement; computer simulation

Circuit requirements: circuit conditions eg $1-\beta A = 0$ at only one frequency, gain-phase relationship in the circuit; frequency determining elements

Build and evaluate: to a given specification a typical circuit configuration eg Wien Bridge, Twin-T, three-section R-C ladder, L-C coupled, transistor or operational amplifier

Specification: factors eg frequency, stability, frequency drift, distortion; need for amplitude stabilization

Crystal oscillators: advantages of crystal controlled oscillator circuits eg frequency accuracy and stability; equivalent circuit of a quartz crystal; fundamental and overtone circuits.

Book referenced

Aircraft electricity and electronics- Thomas K Eismin

24. E16010804 – Boundary Layer Theory and Heat Transfer

***The three modes of heat transfer*:** conduction, radiation and convection, and coupling between conduction and convection (phenomenological approach and introduction of the heat transfer coefficient).

Steady-state energy balance in fixed systems.
Linear models of steady-state heat conduction (resistances and conductances, model and approximation of the fin, special cases of the ideal and infinite fins).
Notions of opaque bodies and transparent media. Spectral and directional intensity and radiation flux. First expression of the radiation flux.
Conservation of energy flux and boundary conditions.
Equilibrium radiation. Spectral and directional absorptivity, reflectivity, and emissivity. Emitted, absorbed, and radiative fluxes. Simple models for radiative transfer.

Physics of unsteady conduction (thermal diffusion phenomenon); characteristic times and lengths. Dimensional analysis. Physical interpretation and application of the Fourier and Biot numbers. The semi-infinite wall model (or short time response model). Spectral analysis of a thermal signal. Degeneracy of the diffusion phenomenon at fixed frequency into propagation.

Modeling of finite systems. Dimensional approach of forced convection. Notions of mechanical and thermal boundary layers. Reynolds, Prandtl and Nusselt numbers. Classical approaches of external and internal convection (limited to fully developed regimes). Laminar-turbulent transition. Notion of hydraulic diameter.

Book referenced
Heat and mass transfer – RK Rajput
Engineering heat transfer- JR Simonsoh
Heat and mass transfer- PK Nag

25. E16010793 – Structural Aerodynamics

***Model and tunnel parameters*:** scale effect; dynamic similarity; Reynolds number; Mach number; wind tunnel types (eg sizes, pressures, temperatures)

***Wind tunnel investigation*:** flow visualisation; lift, drag and pitching moment measurement

***Contribution of wind tunnel tests*:** limitations (eg size, inability to produce extremes of weather etc); aerodynamic development (eg Concorde wing, variable geometry wings, large aircraft configurations); aircraft performance (eg wing profiles, external equipment such as aerials and external loads, etc.)

***Instability modes*:** long and short-period oscillations; spiral dive; Dutch roll

***Common control systems*:** forces; hinge moments; stick forces; stick gearing; trim; trim curves; non-conventional controls; canard; elevons; tailerons; flaperons; active control; artificial stability; control response speed; control power; manoeuvrability; flight envelope protection; weight and drag savings

Less common control configurations: Vertical Take-Off and Landing (VTOL); Very Short Take- Off and Landing (VSTOL); helicopters; variable geometry winged aircraft

Forces on aircraft: gravitational forces due to aircraft manoeuvres; weight, thrust, drag and atmospheric conditions

***Manoeuvres*:** instantaneous level co-ordinated turn and symmetrical pull-up/push-over; load factors; power/thrust for sustained turn and pull-up; spin; incipient; developed; recovery

Manoeuvre envelope: buffet limits; lg-stall; cruise; manoeuvre speeds; limit load factors; gust load lines

Aeroelastic effects: aero elasticity; wing torsional divergence; control reversal; flutter of fixed surfaces and control surfaces; methods of alleviation

***Aircraft Performance*:** aircraft drag and power required versus airspeed curves; minimum drag and power speeds; unpowered flight; glide angle; rate of descent; speed; range; endurance;

stalling speed; powered flight; piston propeller and jet power/thrust available versus airspeed; minimum and maximum level flight speeds; rate of climb; airspeed for maximum rate of climb; absolute and service ceilings; take-off; ground roll; air distance; climb-out; V1; VTD; factors affecting take-off and landing; temperature; pressure altitude; ground effect; wind; runway surface; brakes; airworthiness performance regulations

Book referenced

Megson THG, Aircraft structures for engineering learners

26.E16010795 – Hypersonic Aerodynamics – 1

General characteristics of hypersonic flow.

***Basic governing equations*:** concept of equilibrium and nonequilibrium flows, transport properties; Basic conservation equations and species continuity equation, hypersonic shock and expansion relations, hypersonic similarity parameters.

***Surface pressure distribution in hypersonic flowfield*:** Newtonian, modified Newtonian, tangent wedge and coneand shockexpansion techniques; Pressure distribution in separated regions and in reacting flows.

***Approximate and exact methods in hypersonic inviscid flows*:** Mach number independence, small disturbance theory, thin shock layer theory, Blast wave theory, method of characteristics, correlation for hypersonic shock wave.

***Boundary layer and Convective heat transfer*:** Self similar and Nonsimilar hypersonic boundary layers, Reference temperature method, hypersonic transition, hypersonic turbulent boundary layer, aerodynamic heating.

***Viscous Interaction*:** Interaction parameter, weak and strong interactions, vorticity interaction, examples of viscous interaction.

***Stagnation Point Field*:** Stagnation point properties, convective and radiative heat flux, shock standoff distance.

***Aerodynamic forces and moments*:** Aerodynamics of typical hypersonic vehicles, dynamic stability, design considerations, Introduction to viscous high temperature flows, reentry aerodynamics, radiative gas dynamics, and rarified flows.

***Experimental methods for hypersonic flows*:** Impulse facilities, hypersonic wind tunnels, shock tunnels, gun tunnels, free piston shock tunnels, expansion tubes etc.

Book referenced

Hypersonic and high temperature gas dynamics – john D.Anderson

27. E16010811 – Human Automation

Design characteristics: unitary; modular; rack-mounted
Input and output devices: mechanical switches; non-mechanical digital sources; transducers; relays
Communication links: twisted pair; coaxial; fibre-optic; networks
Internal architecture: central processor unit (CPU); arithmetic logic unit (ALU); storage devices; memory; opto-isolators; input and output units; flags; shift; registers
Operational characteristics: scanning; performing logic operations; continuous updating; mass input/output (I/O) copying
Forms of signal: analogue (0-10 v dc, 4-20mA); digital
Digital resolution and relationships: 9-bit; 10-bit; 12-bit
Number systems: decimal; binary; octal; hexadecimal; Binary-Coded Decimal (BCD)
Evaluate communication standards: comparison of typical protocols used in signal communication
Evaluate networking methods and standards: master to slave; peer to peer; ISO; IEE; MAP
Logic functions: writing programmes using logic functions based on relay ladder logic (AND; OR; EXCLUSIVE OR; NAND; NOR)
Write programs: use of ladder and logic diagrams; statement lists; Boolean algebra; function diagrams; graphical programming languages; production of a PLC
Advanced functions: less than; greater than; binary to BCD conversion; proportional feedback control
Producing and storing text: contact labels; rung labels; programming lists; cross-referencing
Test and debug programs: forcing inputs, forcing outputs; changing data; comparing files (tapes, EPROM, disc); displayed error analysis
Associated elements: contacts; coils; timers; counters; override facilities; flip-flops; shift registers; sequencers
PICs and other programmable devices: specification and use of PICs and other programmable devices; embedded controllers
PLC simulators: compare operation and functionality; advantages and limitations

Book referenced

Intelligent automation -Ian braking
Automation and human performance – raja Parasuraman

28. E16010807 – Communication Embedded system and Network

Legal requirements: licensing; regulatory authorities; frequency of operation; spurious emissions

Amplitude modulation (AM) transmitters: principles of transmission (eg electromagnetic radiation, electromagnetic spectrum and propagation of radio waves); types and principles of modulation; use of block/flow diagrams to aid explanation of the operation and stages within a transmitter system

Receivers: principles of radio reception (eg demodulation, Automatic Gain Control (AGC), Automatic Frequency Control (AFC)); types of receivers; use of block/flow diagrams of radio receiver systems; operation of stages within receivers; effects of noise and interfering signals on radio reception; signal to noise

Receiver performance: use of measurement and test equipment (eg signal generator, power meter, oscilloscope, noise test set, spectrum analyser); performance characteristic (eg sensitivity, signal to noise, adjacent channel, image channel rejection ratios)

Type of radio navigation systems: instrument landing system (ILS); very high frequency (VHF) omni-directional radio range (VOR); automatic direction finding (ADF); distance measuring equipment (DME); logan and omegal; global positioning systems (GPS)

Principles of operation: frequency bands; aerial pattern; system block diagrams; hyperbolic patterns; signal formats; GPS position determination

Aircraft systems: use of block diagrams to identify and explain a typical integrated aircraft radio navigation system; operation of the complete system

Principle and operations: basic principles relating to Inertial navigation; Schuler tuning; block diagram of Schuler tuned INS; accelerometers; gyros; alignment and gyro compassing; errors; choice of platform axes; strap-down IN systems; aided IN systems; Kalman filters

Aircraft IN system: use of block diagram of complete IN system; applications of a typical align sequence; IN augmentation (eg using Doppler, GPS, Kalman Filter); operating principles of analogue computing systems as used in navigation systems

IN Problems: calculation on acceleration, velocity, distance; errors encountered in IN systems and how corrections are applied

Radar systems: pulsed; carrier wave (CW); primary; secondary; Doppler; applications of each system; use of block diagrams of typical radar systems

Parameters measured: range/bearing/height; radar equation; solve problems related to range/bearing/height

Book referenced

Communication system – Simon haykin
Communication Embedded systems networks application- Francis krief

29. E16010812 – Computational Tools

Equations of Fluid Dynamics and their classification. Boundary conditions.

Finite difference schemes: Projection and truncation error, Stability, consistency, accuracy and convergence of numerical schemes. Time marching methods. FDM applied to linear advection - diffusion equation, MacCormack scheme and its application to Euler and N-S equations.

Basics of Finite Volume Method: Equations in integral form, numerical flux at cell faces, upwind methods, flux - vector splitting, flux- difference splitting, shock capturing methods.

Basics of Finite Element Method: Isoparametric elements, bilinear and tri-linear elements. Numerical Integration, space function, Petrov- Galerkin method.

Computation of turbulent flows; RANS, turbulence modelling.

Grid generation: algebraic and pde based methods, O-, C-, H-type topologies, unstructured meshes, hybrid meshes.

Large scale problems in CFD, iterative solvers, preconditioning techniques, vector and parallel computing, post- processing for visualisation.

Book referenced

An introduction to Computational fluid dynamics- H . Versteog

Computational fluid dynamics – Tapan K . Senguptan

30. E16010805 – Aerospace Software Engineering

Introduction to Engineering and Computer Science: Introduction to the Engineering and Computing professions, professional ethics. Overview of ECS curricula, connections among ECS fields and to the basics of sciences, other fields. Basic study, problem solving and other skills needed to succeed as an ECS major. Engineering design and quantitative methods using MATLAB. Multi-disciplinary team projects designed to replicate decision processes in real-world situations.

***Individual Instruction in Computer Science/Software Engineering*:** Individual study under a faculty member's direction.

Mathematical Foundations of Software Engineering : Boolean logic, first-order logic, models of first-order logic. Introduction to program verification, applications in Software Engineering. Completeness Theorem. Regular expressions, regular sets, finite-state machines, and applications

in Software Engineering. Graph Theory, graph algorithms. Statecharts, Petri Nets and their role in Software Engineering.

Computer Architecture: This course introduces the concepts of computer architecture by going through multiple levels of abstraction, and the numbering systems and their basic computations. It focuses on the instruction-set architecture of the MIPS machine, including MIPS assembly programming, translation between MIPS and C, and between MIPS and machine code. General topics include performance calculation, processor datapath, pipelining, and memory hierarchy.

Probability and Statistics in Computer Science and Software Engineering: Axiomatic probability theory, independence, conditional probability. Discrete and continuous random variables, special distributions of importance to CS/SE, and expectation. Simulation of random variables and Monte Carlo methods. Central limit theorem. Basic statistical inference, parameter estimation, hypothesis testing, and linear regression. Introduction to stochastic processes. Illustrative examples and simulation exercises from queuing, reliability, and other CS/SE applications.

Data Structures and Introduction to Algorithmic Analysis: Analysis of algorithms including time complexity and Big-O notation. Analysis of stacks, queues, and trees, including B-trees. Heaps, hashing, and advanced sorting techniques. Disjoint sets and graphs. Course emphasizes design and implementation.

Software Engineering: Introduction to software life cycle models. Software requirements engineering, formal specification and validation. Techniques for software design and testing. Cost estimation models. Issues in software quality assurance and software maintenance.

C/C++ Programming in a UNIX Environment: Advanced programming techniques utilizing procedural and object oriented programming in a UNIX environment. Topics include file input and output, implementation of strings, stacks, queues, lists, and trees, and dynamic memory allocation/management. Design and implementation of a comprehensive programming project is required.

Database Systems: This course emphasizes the concepts and structures necessary for the design and implementation of database management systems. Topics include data models, data normalization, data description languages, query facilities, file organization, index organization, file security, data integrity, and reliability.

Operating Systems Concepts: An introduction to fundamental concepts in operating systems: their design, implementation, and usage. Topics include process management, main memory management, virtual memory, I/O and device drivers, file systems, secondary storage management, and an introduction to critical sections and deadlocks.

Requirements Engineering: Introduction to system and software requirements engineering. The requirements engineering process, including requirements elicitation, specification, and validation. Essential words and types of requirements. Structural, informational, and behavioral requirements. Non-functional requirements. Scenario analysis. Conventional, object-oriented and goal-oriented methodologies.

Software Architecture and Design: Introduction to software design with emphasis on architectural design. Models of software architecture. Architecture styles and patterns, including explicit, event-driven, client-server, and middleware architectures. Decomposition and

composition of architectural components and interactions. Use of nonfunctional requirements for tradeoff analysis. Component based software development, deployment and management.

Software Testing, Verification, Validation and Quality Assurance: Methods for evaluating software for correctness, and reliability including code inspections, program proofs and testing methodologies. Formal and informal proofs of correctness. Code inspections and their role in software verification. Unit and system testing techniques, testing tools and limitations of testing. Statistical testing, reliability models.

Object-Oriented Programming Systems: In-depth study of the features/advantages of object-oriented approach to problem solving. Special emphasis on issues of object-oriented analysis, design, implementation, and testing. Review of basic concepts of object-oriented technology (abstraction, inheritance, and polymorphism). Object-oriented programming languages, databases, and productivity tools.

Software Project Planning and Management: Planning and managing of software development projects. Software process models, ISO 9000, SEI's Capability Maturity Model, continuous process improvement. Planning, scheduling, tracking, cost estimation, risk management, configuration management.

Senior Honors in Computer Science/Software Engineering: For students conducting independent research for honors theses or projects.

Software Engineering Project: This course is intended to complement the theory and to provide an in-depth, hands-on experience in all aspects of software engineering. The students will work in teams on projects of interest to industry and will be involved in analysis of requirements, architecture and design, implementation, testing and validation, project management, software process, software maintenance, and software reengineering.

Undergraduate Topics in Computer Science/Software Engineering: Subject matter will vary from semester to semester. May be used as SE Guided Elective on SE degree plans.

Undergraduate Research in Computer Science/Software Engineering: Topics will vary from semester to semester.

MATLAB and introduction with applications- Amos Gilat

My SQL – Vikram vaswani

31. E16010809 – Computer system

***Microprocessor device families*:** comparison based on speed, cost, i/o facilities, instruction set, physical size

***Applications*:** control systems (eg car engine management, robotics, distributed control systems, coin-operated machines, printers); instrumentation systems (eg data acquisition and logging systems, indicator display systems, ‘intelligent’ panel instruments, test equipment); communication systems (eg facsimile machines, modems, radio transmitters, radar systems); commercial systems (eg electronic funds transfer at point of sale systems (EFTPOS), electronic bank teller machines, hand-held stock loggers, personal computers)

***Design software*:** algorithms in the form of a structure chart showing actions and conditions or in pseudo code (structured English)

Write programs: for applications requiring interfacing to external devices (eg lights, switches, motors, heaters, keypads, LCD and LED displays, printers, ADCs and DACs); use of assemblers and high-level language compilers (eg C, Pascal)

Test software: suitable test data (eg inputs and expected outputs) should be prepared prior to running programs and results of the tests should be documented; use of software debugging tools (eg Integrated Development Environment (IDE), In-Circuit Emulation (ICE), simulators)

Programmable interface devices: serial and parallel interfaces; UARTs; PPIs; I/O mapped devices; memory mapped devices; control signals; interrupts; polling; handshaking; port current rating

Design, build and test: a programmable interface; select and use devices; write and test suitable software in assembler or high-level language

32. E16010802 – Aerothermodynamics

Mission and requirement

Inviscid and viscous hypersonic aerodynamics

An introduction to real gas effect

Aerothermodynamic instrumentations

Measurements of hypersonic flowfields

Species composition measurements in nonequilibirium high-speed flows

Computational techniques for hypersonic flows

Laminar-turbulent transition problems in supersonic and hypersonic flows

Shock/shock and shock-wave/boundary layer interactions in hypersonic flows

Book referred

Aerothermodynamics of gas turbine and rocket propulsion –Gordon C oates

33.E16010789 – Satellite Application

***Introductions to GNSS*:** Conventional navigation, background, concepts and evolutions of global navigation satellite systems (GPS, GLONASS, Galileo, BeiDou/ COMPASS) and regional navigations satellite systems (IRNSS, QZSS). Comparison of GNSS with other navigation systems;

Reference systems: Terrestrial, celestial and orbit coordinate reference system. Height Systems. Geoid. Time systems, synchronization and data conversion. Transformations between coordinate reference systems. Contribution of the International GNSS Service (IGS) to providing access to the International Terrestrial Reference Frame (ITRF);

***Satellite orbits*:** Orbital parameters. Orbital motion, representation (Keplerian elements, etc.) Determination of satellite position, visibility and ground tracks;

***Basic techniques of communications*:** Propagation of electromagnetic waves. Antennas and propagation channels. Signal modulation and multiple accesses. Signal processing.

Inertial navigation systems. Accelerometer, Gyroscopes, Inertial platforms, Navigation equation, Integration of modelling equations in e-frame;

***INS error dynamics*:** Simplified analysis, Error dynamics equations in e-frame, INS initialization and alignment;

***GNSS/INS integration*:** Integration mode, Mathematical model of supported INS navigation, Observation procedures for inertial surveying; 6.4. General sensor fusion concepts.

***Receiver architecture*:** Technology, radio-frequency front end, signal processing system hardware and software techniques, software defined radio;

***Signal tracking*:** Maximum likelihood estimate of delay and position, delay lock tracking of signal, coherent and non -coherent delay lock tracking of pseudo noise sequences, mean square error estimation, vector delay lock loop, receiver noise performance, maximum likelihood estimate, early late gating;

***Navigation algorithm*:** Measurement of pseudo range, Doppler, decoding and using of navigation data, single point solution, precise point positioning, dynamics of user, Kalman filter, least-squares adjustment, and other alternatives

***Geospatial databases*:** Geo extensions for Open Source Databases, POSTGRES, MySQL etc.

***GNSS navigation*:** Professional and personal, GIS/mapping, Surveying, Natural Hazards management, Earth sciences, Natural resources, Infrastructure; Navigation and communication: Integrated application; Communication, navigation and surveillance: Integrated application;

***GNSS applications for remote sensing of the atmosphere and space weather*:** Radio occultation technique for monitoring terrestrial weather (temperature and water vapour) and monitoring ionosphere weather (electron density and total electron content) .

Book referred:
Satellite communication concepts and applications –K.N.Raja Rao
Satellite communication fundamentals – Thomas W R East

34. E16010803 – Vehicle Propulsion

Classification: Duct Jet Propulsion, Rocket Propulsion, Application of Rocket Propulsion.

Definitions and Fundamentals: Definitions, Thrust, Exhaust Velocity, Energy and Efficiencies, Typical Performance Values.

Nozzle Theory and Thermodynamic Relations: Ideal Rocket, Summary of Thermodynamic Relations, Isentropic flow through Nozzles.

Nozzle Theory and Thermodynamic Relations: Nozzle Configurations, Real Nozzles, Four Performance Parameters, Nozzle Alignment, Variable Thrust.

Flight Performance: Gravity-Free Drag-Free Space Flight, Forces Acting on a Vehicle in the Atmosphere, Basic Relations of Motion, Effect of Propulsion System on Vehicle Performance, Space Flight.

Flight Performance: Flight Maneuvers, Flight Vehicles, Military Missiles, Aerodynamic Effect of Exhaust Plumes, Flight Stability.

Chemical Rocket Propellant Performance Analysis: Background and Fundamentals, Analysis of Chamber or Motor Case Conditions.

Chemical Rocket Propellant Performance Analysis: Analysis of Nozzle Expansion Processes, Computer Analysis, Results of Thermochemical Calculations.

Liquid Propellant Rocket Engine Fundamentals: Propellants, Propellant Feed Systems, Gas Pressure Feed Systems, Propellant Tanks.

Liquid Propellant Rocket Engine Fundamentals: Tank Pressurization, Turbopump Feed Systems and Engine Cycles, Flow and Pressure Balance, Rocket Engines for Maneuvering, Orbit Adjustments, or Attitude Control, Valves and Pipe Lines, Engine Support Structure.

Solid Propellant Rocket Fundamentals: Propellant Burning Rate, Basic Performance Relations.

Solid Propellant Rocket Fundamentals: Propellant Grain and Grain Configuration, Propellant

Book referenced

Farokhi, Saeed. **Aircraft propulsion / Saeed Farokhi**

Fundamentals of Aircraft and Rocket Propulsion Ahmed F. El-Sayed

35 – Spacecraft Design and Performance

***Preliminaries*:** Aircraft Design Requirements, specifications, role of users, Aerodynamic and Structural Consideration, Importance of weight. Airworthiness requirements and standards. Classifications of airplanes. Special features of modern airplane.
Air Loads in Flight: Symmetrical measuring loads in flight, Basic flight loading conditions, Load factor, Velocity - Load factor diagram, gust load and its estimation, Structural limits.
Airplane Weight Estimation: Weight estimation based on type of airplane, trends in wing loading, weight-estimation based on mission requirements, iterative approach
Basics of Wing Design: Selection of airfoil selection, influencing factors. Span wise load distribution and planform shapes of airplane wing. Stalling, take off and landing considerations. Wing drag estimation. High lift devices
Structural Design: Cockpit and aircraft passenger cabin layout for different categories, types of associated structure, features of light airplanes using advanced composite materials. Structural aspects of design of airplane, Bending moment and shear force diagram. Design principles of all metal stressed skin wing for civil and military applications
Landing Gears: Different kinds of landing gears, and associated arrangement for civil and military airplanes. Preliminary calculations for locating main and nose landing gears.
Integration of Structure and Power Plant: Estimation of Horizontal and Vertical tail volume ratios. Choice of power plant and various options of locations, considerations of appropriate air -intakes. Integration of wing, fuselage, empennage and power plant. Estimation of centre of gravity.
Introduction to advanced concepts: Supercritical Wings, relaxed static Stability, controlled configured vehicles, V/STOL aircraft and, rotary wing vehicles.
Design and layout of flying controls and engine controls

Book referenced

Aircraft performance and design – john D Anderson Aircraft design: A conceptual approach – Dennial P Raymer

36 E16010810 – Spacecraft Launch

Technology Skills for Astronautics: Self-paced course designed to provide the programming, modeling and simulation skills required in the various courses in the astronautical engineering major. Students are introduced to the MatLabTM/SimulinkTM tools for programming, modeling and simulation and to state-of-the-art 3-D computer tools for satellite analysis and visualization.

Introduction to Astronautics: Introduction to the history, principles and challenges of space. Examines elements of space missions including orbits, spacecraft systems, launch vehicles, re-entry, operations and mission management. Emphasis on understanding the underlying physical principles and the system engineering process used to select orbits, plan maneuvers, and accomplish preliminary design of spacecraft payloads/subsystems to meet mission requirements. Reinforces concepts through hands-on use of application-based analysis and visualization software and communication of learned principles through written reports.

Intermediate Astrodynamics: Intermediate course in orbit mechanics. Topics include orbit determination and prediction, orbit maneuvers, perturbations, rendezvous and proximity operations. Emphasizes the design and use of structured computer programs to solve real-world astrodynamics problems. Programming experience is recommended.

Space Systems Engineering: Presents fundamentals of space vehicle design with an emphasis on systems engineering. Introduces system-level spacecraft design issues including reliability, environments, radiation effects, testing, materials engineering, integration, launch vehicles and operations. Introduces and analyzes payloads, structures, propulsion, electrical power, communications and data handling, attitude determination and control, and thermal control subsystems. Includes an integrated lab experience where small teams analyze and integrate subsystems into a functioning small satellite called “EyeasSat.” Teams demonstrate and document their EyeasSat at the system level as a part of the final evaluation.

Rocket Propulsion: Introduces rocket propulsion and propulsion system design. Uses the basic laws of thermodynamics, thermochemistry and conservation to determine ideal motor performance. Emphasis on describing the components and conceptual design criteria for liquid, solid and hybrid rockets. Also studies electric, nuclear and other advanced propulsions systems.

Advanced Astrodynamics: Continuation of Astro Engr 321, focuses on applying numerical and analytical techniques to solve realistic Air Force problems in astrodynamics and space operations. Examines perturbations and the associated effects on satellite orbits. Applies Least Squares and Kalman filter estimation techniques to the orbital prediction problem using batch

and sequential processing. Uses structured computer programming extensively in problem solutions

Space Mission Design: Examines basic mission design principles for Air Force and civilian launch systems. Studies mission objectives and constraints; feasibility studies; time-line generation; launch, on-orbit and recovery operations; and contingency planning. Applies structured computer programming to analyze typical space missions.

Small Spacecraft Engineering I: Introduction to small satellite systems engineering. Multi-disciplinary system design of spacecraft hardware and software to include subsystems, propulsion systems, attitude determination and control systems, electrical power systems, structures, payloads and ground stations. Define mission and system requirements, perform engineering trade studies, design and analyze spacecraft systems, and build and test flight hardware. Also includes opportunities to operate on-orbit small satellites.

Spacecraft Attitude Dynamics and Control: Fundamental introduction to the problem of controlling satellite attitude. Topics include direction cosine and Euler angle attitude parameters, torque-free rigid body motion, flexible body effects and energy dissipation, spin stabilization, gravity-gradient stabilization, momentum and reaction wheel control, and reaction jet control. Projects include the development of a satellite attitude dynamics simulation and the design of a reaction wheel and reaction jet attitude control system. Includes analysis and synthesis with Mat Lab simulation.

Book referenced:
Understanding space – jerry jon sellers

37. E16010806 – Space Exploration

Introduction

<u>History of Space Exploration and Development;</u> Early Space Exploration; The Space Race; Timeline of the Space Race; The Future of NASA and Space Exploration; Vision; Obama Administration and NASA; Space Policy

<u>Understanding Space;</u> Structure of the Atmosphere; Space Terminology; Affirmative Arguments and Case Ideas; Spinoff Technology; Notable Spinoffs; Negative Response; Space Militarization and Weaponization; Affirmative Arguments; Negative Response; Discovery and Human Spirit; Affirmative Arguments; Negative Response; Staffed Mission to the Moon; Vehicle for Human Transportation; Transportation in Debate Rounds; Negative Response; Staffed Mission to Mars; Affirmative Arguments; Negative Response

<u>International Space Station;</u> Utilization of the International Space Station; Transportation to the International Space Station; Affirmative Case Ideas; Negative Response; Unstaffed Missions; Mars Rover; Negative Response; Human Travel Better; Logistics; Cost

Asteroid; Asteroid Mapping; Asteroid Mining; Negative Response; Satellites; Weather; Communication; Negative Response; International Cooperation; Affirmative Arguments; Negative Response; Asteroid Mapping; Asteroid Mining; Negative Response

<u>Medical Research;</u> Affirmative Arguments; Negative Response; Space Colonies; Why Space Colonies?; Negative Response; Extra-Terrestrial Intelligence; Methods; Radio Experiments

Observational Experiments; Other Potential Cases; Negative Response; Wasteful; Malevolent Life Forms; Major Negative Arguments; Cost; Better Investment Elsewhere; Spinoffs; NASA Tradeoff Disadvantage.; Privatize; Lower Cost; Innovation; Privatization in the Status Quo; Regulations and Red Tape

<u>Launch Systems;</u> International Space Station; Satellites; Space Tourism; Energy; Ocean Floor Counterplan; Topicality; Its Substantially Increase; Exploration and Development; Space beyond the Mesosphere

Book referenced

Outer space exploration – john logsdin

38. E16010799 – Basic Pyrotechnics

Introduction; Orientation and administration; organizational paper work; formative test; summative test

Laws and regulations

Fireworks; classification; safe and sane; agriculture and wildlife; model rocket motor; emergency signaling device; snap caps and snappers; licenses and permits; identify the state fire marshal seal of registration

Proximate fireworks/special effects; physical hazards; storage requirements; types of devices; requirements for various types of pyrotechniques

Public display; public display permit; identifying firing methods; mortars and aerial shells; site location requirements; safety tools and equipments; personal protective equipments; post display procedures

Model rockets; requirements for model rockets; physical hazard

Seizing firework; disposing of firework

Explosives; types of regular explosives; display and storage requirements

Firework classification

Book referenced –

Chemistry of pyrotechnics: basic principal and theory- Chirs mocella

39. E16010808 – Transportation

System Command Input; Specifications for movement of goods and people; Safety considerations; Vehicle design specifications; Economic qualifications; Expected Impacts; Environmental; Economic; Societal; Personal; Resources; People Job classifications; Career opportunities; Historical technical advances; Information systems; Maps; Operating and servicing manuals; Safety; Materials; Vehicle construction materials; Characteristics and design considerations; Tools/Machines; Identification; Function/selection; Utilization and safe operating techniques; Maintenance; Capital; Source; Effect on development; Energy; Types and sources; Conversion and applications; Time; Requirements/quantity; Management and outcomes

Process; Modes; Fixed (rail); Random (auto, recreational); Stationary (pipeline, conveyor, elevator); Vehicle Subsystems; Propulsion (engine types); Structure (frame, body); Suspension (wheels, tracks, air cushion); Guidance and control; Output; Service Provided/Goods Delivered;

Impacts; Environmental; Economic; Societal; Personal; Monitor and Control; Types and Methods; Purposes

Book referenced

Transportation planning principles –Pradeep Kumar Sarkar

40.E16010797 – Design and Development of Aircraft

Customer requirements: all relevant details of customer requirements (eg aesthetics, functions, performance, cost and production parameters) are identified and listed

Design parameters: implications of specification parameters and resource requirements are identified and matched; the level of risk associated with each significant parameter is established

Design information: all relevant information is extracted from appropriate reference sources; techniques and technologies used in similar products or processes are identified; use of new technologies are specified where appropriate; relevant standards and legislation are identified and applied throughout

Analysis of possible design solutions: selection and use of appropriate analysis techniques to achieve a design solution (eg matrix analysis, brainstorming, mind mapping, forced decision making)

Evaluation: costs; future development potential; value engineering concepts

Compliance check: using checklists; design review procedures

Report: communicate rationale for adopting proposed solution; use of appropriate techniques and media in the presentation of the report (eg sketches, charts, graphs, drawings, spreadsheets/databases, CAD, DTP, word-processing)

Key features of a computer-aided design system: 2D design and 3D modelling systems (eg accessing standards, parts and material storage and retrieval, engineering calculations, PCB

layouts, integrated circuit design, circuit and logic simulation — including AC, DC and transient analysis, schematic capture)

Software: accessing and using appropriate design software (eg parts assembly, pipework and ducting layouts, networks, planned maintenance, scheduling, planning, stress and strain, heat transfer, vibration analysis, resourcing, utilisation, plant layout, costing, circuit emulation, plant electrical services, for example, finite element analysis and printed-circuit board analysis software) Note: centres should select suitable examples from the applications listed

Evaluation: consideration of costs, compatibility and function

Books

Aircraft performance and design – J D ANDERSON

Aircraft Design- Daniel Raymer

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