Table of Contents – Aeronautical

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.

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 discretization methods such as FDM, FVM, FEM; concept of state update formula.

3. E16010766 - Electrical and Electronics Engineering

Series and parallel LCR circuits: voltage, current and power with sinewave signals; conditions for resonance (eg freuency 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. DAE04044 - 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.

5. E16010771 - 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 soild 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 deadload 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. E16010768- 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. Analyse and model engineering situation and solve engineering problems using series and numerical methods for solution of ordinary differential equations.
2. Analyse and model engineering situation and solve engineering problems using Laplace transforms.
3. Analyse and model engineering situation and solve engineering problems using Fourier series.
4. Analyse 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 ($C_{y\beta}$), Flight Test to estimate yawing Moment Coefficient ($C_{n\beta}$), Flight Test to estimate Roll Derivative ($C_{l\beta}$), 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.

8. DAE0450 – Microprocessors 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 programmes, 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

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

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.

12. DAE05055 - 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 transgranular fracture by microvoid coalescence; brittle transgranular fracture (cleavage); transgranular and intergranular fracture by fatigue; the effects of fracture path and microstructure; material behaviour and mechanisms of fracture
Micromechanics and properties: mechanical properties of unidirectional composites (eg longitudinal stiffness and tensile strength, transverse stiffness and strength); fibre volume fraction and the equation of mixtures; off-axis stiffness and strength; properties of cross-ply and angle-ply laminates; discontinuous fibre laminates; the use of fibre 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 aluminium alloys, titanium alloys, phosphoric acid anodising, chromic acid anodising)
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 categorisation (non-structural, secondary structural and primary structural), non-patch repairs, bonded external patch, scarft 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 organisation); 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 analyse 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.

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

15. DAE05054- 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.

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
Turbines: 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)
Pressure ratio: 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

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
: 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

18. DAE04049 - 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 moulding and shaping
Moulding 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 moulding 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 moulding 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. DAE04040 - 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. E16010792– Aircraft Material

Engineering Materials, 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. **Mechanical Testing.** 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.
Furnishing Materials: Plastic, wood, plywood, glue, dopes and rubber used in aircraft manufacture. Methods of testing and storage. Paints, surface finishes and materials. **Specifications:** Indian Standard, British, American, French, German, and International specifications.
Corrosion, its detection and prevention. 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.

22. 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 stabilisation

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

23. 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.

24. 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: aeroelasticity; 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

26. 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

27. 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

28. Strength of Materials

Introduction : Concept of Stress, axial loading normal stress, shearing stress, bearing stress, stress on an oblique plane under axial loading.
Deformation : Concept of strain, normal strain under axial loading, stress-strain diagrams, Hooke's law, modules of elasticity, Poisson's ratio, thermal stresses, bulk modulus, modulus of rigidity, shearing strain, stress-strain relationship.
Transformation of Stress and Strain : Principal stresses, maximum shearing stress, Mohr's circle for plane stresses. Stresses in thin-walled pressure vessels, measurement of strain Rosette.
Pure Bending : Deformation in a transverse cross-section, derivation of formula for bending stresses. Bending stresses in composite sections.
Shearing Force and Bending Moment : Diagram for simply supported Beam, Cantilevers, with concentrated, uniformly distributed and variable loads. Castigliano's theorems, unit load method.
Deflection of Beams : Deflection in simply supported beams and cantilevers with concentrated loads, uniformly distributed loads and combination of these. Macaulay's method, moment area method.
Springs : Design of Helical (closed coiled) springs and leaf springs.
Columns : Euler formula for pin-ended columns and its extension to columns with other end conditions. Rankine Gordon formula.
Torsion : Deformation in a circular shaft, angle of twist, stresses due to torsion, derivation of torsion formula, torsion in composite shafts.
Loads on Airplane Components: Steady and unsteady load.
Text Books :
1. S Ramamrutham, Strength of Materials, Dhanpat Rai Publishing Co.
2. E P Papov, Mechanics of Materials, Prentice Hall Inc.
3. U C Jindal, Strength of Materials, Umesh Publications
Reference Books :
1. S Timoshenko, Strength of Materials, D Van Standard Co. Inc.

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.

30. 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

31. PSM2 : Maintenance of Airframe Systems.

Airframe Structure : Various types of structures in aiframe construction, tubular, braced monocoque, semimonocoque, etc, longerons, stringers, formers, bulkhead, spars and ribs, honeycomb construction. Airplane controls, ailerons, elevators, rudder, trimming and control tabs, leading and trailing edge flaps, tailplane and fins. Basics of structure and structural components fabricated from metal, glass fibre, vinyl, prespex, composites. Finishing materials, paints, surface finishes and associated materials.

Aircraft systems : Flying controls including power operated controls, hydraulic, pneumatic, landing gear various types, shock struts, nose wheel steering, ice and rain protection, fire detection warning and extinguishing, oxygen, air - conditioning and pressurisation systems, wheels, tyres, brakes, antiskid system. Windows, doors and emergency exists. Reliability and redundancy of systems design.

Inspection : Basic principles of inspection, inspection gauges, and tools. Standard inspection techniques and procedures. Go/No go gauges, gauge calibration and maintenance, limits and tolerance. NDT techniques.

Major and minor damage, damage tolerance. Corrosion and corrosion prevention. Major and minor defects. Defect reporting, rectification and investigation. Rigging of aircraft, symmetry checks. Balancing of control surfaces, Periodical inspections, heavy landing, overweight landing checks, abnormal flight loads. Aircraft weighing, weight schedule, calculation of centre of gravity.

‡ Electrostatic Sensitive Devices
‡ Electromagnetic Environment

Typical Electronics/ Digital Aircraft Systems

‡ Electronic Centralised Aircraft Monitoring (ECAM)
‡ Electronic Flight Instrument Systems (EFIS)
‡ Engine Indicating & Crew Alert Systems (EICAS)
‡ Fly by Wire (FBW)
‡ Flight Management Systems (FMS)

Text Books and Reference Books :

1. Aircraft Manual, government of India.
2. Civil Airworthiness requirements CAA, UK.
3. FAR's FAA, U.S.A.
4. Parkinson, Engineering Inspection, Wheeler
5. Michacl J. Kroes and James R Fardn, Aircraft Basic Science, McGraw Hill
6. Michacl J. Kroes and William A watkins, Aircraft Maintenance and Repair, McGraw Hill
7. Civil Aircraft Inspection Procedures (CAP 459) Pt II Aircraft, Himalayan Books
8. Airframe and Power Plant Mechanic (AC 65-15A) Airframe Hand Book, Himalayan Books.199

32. E16010795 – Hypersonic Aerodynamics

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, rarified flows.
Experimental methods for hypersonic flows: Impulse facilities, hypersonic wind tunnels, shock tunnels, gun tunnels, freepiston shock tunnels, expansion tubes etc.

33. OS12 : Introduction to finite element methods.

Introduction to differential equations and numerical methods for solution of differential equations; finite difference, collocation, weighted residual methods. Introduction to a second order ordinary differential equation, e.g. stretching of a bar under axial loads or the one-dimensional steady-state heat conduction problem, introduction to the principle of virtual work, weak formulation for differential equation,
definition of energy-norm, admissible functions for approximation.
Introduction to the finite element method for given weak form, essential and natural boundary conditions, construction of basis and shape functions (Lagrangian shape functions), definition of stiffness matrix and load vector, mapping to the master domain, numerical integration, element stiffness matrix and load vector, assembly, charactseristics of the matrix problem, choice of solvers for the matrix problem (skyline, banded or frontal), development of a working one dimensional finite element code.
Convergence characteristics of solution, a-priori error estimates, characteristics of finite element strains and stresses (Flux); postprocessing of finite element solution for recovery of "better" stresses (nodal averaging or extrapolation from Gauss points).
Introduction to Euler -Bernoulli beam theory, weak formulation, smoothness requirements and Hermite shape functions, solution of problem, quality of computed quantities (e.g. displacement, shear force, bending moment), introduction to Timoshenko beam theory, shear locking, shear correction factor, reduced integration.
Steady-state heat conduction problem in two-dimensions, weak formulation, boundary conditions, mesh generation, triangular or quadrilateral elements, connectivity information, linear mapping construction of shape functions (e.g. for triangles, tensor product or serendipity for quadrilaterals), numerical integration; element stiffness matrix, element load vector, assembly, imposition of essential boundary conditions; solution, convergence characteristics of finite element solution, postprocessing of finite element fluxes.
Subparametric, isoparametric and superparametric mappings, transformation from master to physical element; Jacobian calculation.
Introduction to plane stress and plane strain problems. Weak formulation. Essential and natural boundary conditions, construction of element stiffness matrix and load vector, solution of problem, quality of finite element stresses, post processing for better stressess.
Development of a two-dimensional finite element code for the plane stress/strain problems.
Introduction to plate theory; Kirchhoff plate theory, weak formulation; Hermite shape functions in two-dimensions, Rcissner -Mindlin plate theory, higher order plate theories.

Text Books and Reference Books:

1. J.N. Reddy, An Introduction to the Finite Element Method, Mc Graw Hill International.
2. I.H. Shames and S. L. Dyin, Energy and Finite Element Methods in Structural
Mechanics, New Age International Publishers Ltd.
3. O.C. Zienkiewicz and R.L. Taylor, Finite Element Methods: Vol I&II, McGraw Hill, NY.

34. PSM1 : Maintenance of Powerplant Systems

Piston Engines : Two and four stroke engines. Efficiency, factors affecting engine performance. Knowledge of the function and construction of various parts and accessories of the engine including induction, exhaust and cooling system, engine mounting. Engine fire detection and protection systems.
Propellers : Knowledge of purpose and functioning of parts of constant speed, variable pitch and feathering propellers and associated control system components.
Engine fuel and Oil System : Construction, features of carburettors, engine fuel and oil systems. Characteristics of aviation fuel and oil, common sources of contamination, methods of checking contamination.
Ingition and starting systems : Magnetos and ignition system components, various types of engine starters.
Engine Instruments : Principle of operation. Superchargers-constructional features and principles of operation and function of various types of superchargers and its related component.
Gas Turbine : Principle of operation, general constructional details and function of various type of gas turbine engines such as turbojet, turbo fan and by-pass engine. Theory of gas turbine engines, advantages and disadvantages of each type. Induction, exhaust and cooling systems, anticing of engine, engine mountings, thrust augmentation. Compressor surge and stall, bleed control system. Principles of operation, general constructional details and functions of fuel and oil systems, ignition and starting systems and their components. Engine controls of various types, including Full Authority Digital Electronic Control Engine instruments. Power augmentation devices, thrust reversers and auxiliary power units.
Engine Maintenance : Piston/Gas Turbines: Periodical servicing procedures, engine installation checks, control rigging, ground running checks, priming, bleeding and performance checks. Engine on condition maintenance. Trouble shooting and rectification. Inspection after shock landing. Crack detection. Procedure for long and short terms storage of engine and accessories, engine preservation and depreservation.
Text Books and Reference Books :
1. E Mangham and A Peace, Jet Engine Manual, Himalayan Books
2. Jet Engines, Rolls Royce Ltd. 1992
3. Casamassa and Bent, Jet Aircraft Power Systems, Tata McGraw Hill
4. Civil Aircraft Inspection Procedures (CAP 459), Himalayan Books
5. Pratt and Whitney, Gas Turbine Engine
6. Michacl J. Krose Thomas W.Wild, Bent, Aircraft Power Plants, McGraw Hill 1994
7. H Cohen, G F C Rogers and H I H Sarvanmutto, Gas Turbine Theory, John Wiely

8. Irvine Treager, Aircraft Gas Turbine Engine Technology, Tata McGraw Hill 1997

35. OS4: Vibration and Aeroelasticity

Rectilinear Motion of a Particle : Differential equation of motion in a resisting medium. Free vibrations with viscous damping. Forced vibration with harmonic disturbing force and general disturbing force. Plane harmonic motion. Motion of a projectile with and without damping. Motion of a particle subjected to a central force, planetary motion.
Dynamics of System of Particles: Principle of linear momentum and angular momentum. Rectilinear motion of a variable mass, Rockets. Kinetic energy and work. Law of conservation of energy.
Dynamics of a System with Constraints : Equations of constraints. Generalized coordinates. Generalized forces, Equations of equilibrium in generalized coordinates. Application of generalized coordinates in bending of beams. D'Alembert's principle. Lagrange's equation and applications. Hamilton's principle and applications.
Small Oscillations of Conservative Systems : Free vibrations of conservative systems. Linear oscillations of two coupled masses. Free vibration of systems with two degrees of freedom and systems with several degrees of freedom. Principal modes and their orthogonal property. Normal modes, static coupling and dynamic coupling. Approximate methods of calculating principal frequencies.
Dynamics of Elastic Bodies : Vibration of a string under tension. Free vibration of beams with various end condition and the determination of the various modes of vibration and their natural frequencies. Vibration of beams with concentrated masses. Critical speed of a rotating shaft. Forced vibration of beams. Torsional vibration of a shaft and disc-shaft combination. Approximate methods of calculating natural frequencies.
Aeroelasticity : Elements of aeroelasticity. General nature of aeroelastic problems. Nature of static aeroelastic phenomenon. Wing divergence and control system reversal for an idealized two dimensional wing and approximate solution for a finite wing. Flutter phenomena and flutter analysis. Difference between flutter instability and resonance. Simplified expressions for aerodynamic forces and moments for an oscillating airfoil. Determination of flutter speed and frequency for an idealized two dimensional wing as well as for a finite wing. Methods of flutter control and prevention. Elementary theory of buffeting.
Text Books and Reference Books:
1. S Timoshenko, Vibration Problems in Engineering, Van Nostrand. 1982
2. W T Thomson, Vibration Theory and Application, Allen and Unwin
3. Y C Fung, Introduction to the Theory of Aeroelasticity
4. R L Bisplinghoft, H Ashley and R L Halfman, Aeroelasticity, Addison Wesley.

36. 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
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.

38. 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

40. OS3 : Wind Tunnel Testing

Aerodynamic testing facilities for different speed regimes, low speed wind tunnels, main features of supersonic, transonic and hypersonic tunnels, shock tunnels, closed and open circuit tunnels.

Design of contraction and diffuser and other components. Instrumentation and calibration of test section.

Testing procedure, data reduction, blockage effects and boundary layer corrections, correction to lift drag, moment coefficient due to wind tunnel wall interference.

Measuring devices, pitot static tube, yaw probes, five hole probe, hot wire anemometers, scanivalve system; Flow visualization techniques oil flow, tuft survey and smoke.

Flow field pressure measurements, Schlieren, shadowgraph and interferometer technique, laser Doppler anemometer; Wind tunnel balances, mechanical and strain gauge balances and their design. Scale effects.

Non - aeronautical use of wind tunnels.

Text Books:

1. W H Rae Jr and Allen Pope, Low Speed Wind Tunnel Testing, John Wiley & Sons,
2nd Ed.
2. A Pope and L K Goin, High Speed Wind Tunnel Testing, John Wiley & Sons
3. A Pope and J J Harper, Low Speed Wind Tunnel Testing, John Wiley & Sons.

Reference Books

Goethert B H, Transonic Wind Tunnel Testing, Pergaman Press