**BACHELOR OF TECHNOLOGY (AERONAUTICAL ENGINEERING) CREDIT BASED**

**KURUKSHETRA UNIVERSITY KURUKSHETRA**

**SCHEME OF STUDIES/EXAMINATION**

**SEMESTER-VII *w.e.f.*2021-22 ONWARDS**

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| **S. No.** | **Course Code** | **Course Title** | **Teaching Schedule** |  | **Examination Schedule (Marks)** | **Duration of Exam****(Hrs.)** |
| **L** | **T** | **P** | **Hours/Week** | **Credit** | **Major Test**  | **Minor Test** | **Practical** | **Total** |  |
| 1 | AEO\* | Open Elective-I | 3 | 0 | 0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 2 | AER-401A | Avionics | 3 | 0 | 0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 3 | AER-403A | Avionics Lab | 0 | 0 | 2 | 2 | 1 | 0 | 40 | 60 | 100 | 3 |
| 4 | AER-405A |  Project-III | 0 | 0 | 10 | 10 | 5 | 0 | 100 | 100 | 200 | 3 |
| 5 | AEP\* | Program Elective – III | 3 | 0 | 0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 6 | AEP\* | Program Elective-IV | 3 | 0 | 0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 7 | \*\*AER-407A | Industrial Training-III | 2 | 0 | 0 | 2 | - | 0 | 100 | 0 | 100 |  |
|  |  | **Total** | **14** | **0** | **12** | **26** | **18** | **300** | **240** | **160** | **700** |  |

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| **Program Elective-III** | **Program Elective-IV** | **Open Elective-I** |
| **Course Code** | **Course Title** | **Course Code** | **Course Title** | **Course Code** | **Course Title** |
| AEP-401A | Principles of Helicopter Engineering | AEP-409A | Computational Fluid Dynamics | AEO-401A | Flight Dynamics |
| AEP-403A | Boundary Layer Theory | AEP-411A | Finite Element Methods | AEO-403A | Aircraft Communication and Navigation Systems |
| AEP-405A | Aircraft Maintenance of Power Plant and Systems | AEP-413A | Aircraft Maintenance of Airframe and Systems | AEO-405A | Experimental Aerodynamics |
| AEP-407A | Fuels and Propellant Technology | AEP-415A | Ergonomics in Aerospace | AEO-407A | Microprocessor and Interfacing |

***Note:***

1. \**The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.*

2. \*\*AER-407A is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone after 6th semester and students will be

required to get passing marks to qualify.

**BACHELOR OF TECHNOLOGY (AERONAUTICAL ENGINEERING) CREDIT BASED**

**KURUKSHETRA UNIVERSITY KURUKSHETRA**

**SCHEME OF STUDIES/EXAMINATION**

**SEMESTER-VIII *w.e.f.*2021-22 ONWARDS**

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| **S. No.** | **Course Code** | **Course Title** | **Teaching Schedule** |  | **Examination Schedule (Marks)** | **Duration of Exam(Hrs.)** |
| **L** | **T** | **P** | **Hours/Week** | **Credit** | **Major Test**  | **Minor Test** | **Practical** | **Total** |  |
| 1 | AER-402A | Project-IV | 0 | 0 | 10 | 10 | 5 | 0 | 100 | 100 | 200 | 3 |
| 2 | AEO\* | Open Elective-II | 3 | 0 | 0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 3 | AEO\* | Open Elective-III | 3 | 0 | 0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 4 | AEP\* | Program Elective-V | 3 | 0 | 0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 5 | AEP\* | Program Elective-VI | 3 | 0 | 0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
|  |  | **Total** | **12** | **0** | **10** | **22** | **17** | **300** | **200** | **100** | **600** |  |

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| **Open Elective-II** | **Open Elective-III** |
| **Course Code** | **Course Title**  | **Course Code** | **Course Title** |
| AEO-402A | Wind Tunnel Techniques | AEO-410A | Rockets and Missiles |
| AEO-404A | Robotics and Automation | AEO-412A | Introduction to Automatic Flight Control |
| AEO-406A | Computer Aided Design | AEO-414A | Aerospace Power Electronics |
| AEO-408A | Product Design and Manufacturing | AEO-416A | Non-Destructive Testing |

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| **Program Elective-V** | **Program Elective-VI** |
| **Course Code** | **Course Title**  | **Course Code** | **Course Title**  |
| AEP-402A | Space Dynamics | AEP-410A | Air Transportation and Aircraft Maintenance Management |
| AEP-404A | Aircraft Quality Control, Quality Assurance and Certification | AEP-412A | Aircraft Modeling and Simulation |
| AEP-406A | Aircraft Systems and Instrumentation | AEP-414A | Control Theory and Practices |
| AEP-408A | Theory of Vibrations | AEP-416A | Mechatronics |

***Note:****1.*\**The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section*

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AER-401A** | **AVIONICS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To familiarize the students with the applications of electronics in Aeronautical Engineering** |
| **Course Outcomes** |
| **CO1** | **Introduction to Avionics** |
| **CO2** | **Introduction to the principles of digital systems and its avionics architecture** |
| **CO3** | **Understanding the concept of electronic equipment in flight deck and cockpits** |
| **CO4** | **Introduction to the types of Avionics Systems** |

**Unit-I**

Need for Avionics in civil and military aircraft and space systems – Integrated Avionics and Weapon system – Typical avionics sub systems – Design and Technologies.

**Unit-II**

Digital Computers – Microprocessors – Memories

Avionics system architecture–Data buses MIL–STD 1553 B–ARINC 429–ARINC 629.

**Unit-III**

Control and display technologies CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) - Civil cockpit and military cockpit: MFDS, HUD, MFK, HOTAS

**Unit-IV**

Communication Systems - Navigation systems - Flight control systems - Radar electronic warfare

- Utility systems Reliability and maintainability - Certification.

**Text Books:**

1. Malcrno A.P. and Leach, D.P., “Digital Principles and Application”, Tata McGraw-Hill, 1990.

2. Gaonkar, R.S., “Microprocessors Architecture – Programming and Application”, Wiley and Sons Ltd., New Delhi

**Reference Books:**

1. Middleton, D.H., Ed., “Avionics Systems, Longman Scientific and Technical”, Longman Group UK Ltd., England,

2. Spitzer, C.R., “Digital Avionic Systems”, Prentice Hall, Englewood Cliffs, N.J., USA. 1987. Brain Kendal, “Manual of Avionics”, The English Book House, 3rd Edition, New Delhi,

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AER-403A** | **AVIONICS LAB** |
| **L** | **T** | **P** | **Credit** | **Practical** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **2** | **1** | **60** | **40** | **100** | **3h** |
| **Purpose** | **To give the practical knowledge of handling the avionics related instruments.** |
| **Course Outcomes** |
| **CO1** | **TomakethestudentsfamiliarwiththeexperimentsrelatedwithAvionics** |
| **CO2** | **To make students apply hands on approach on Avionics instruments** |

**DIGITAL ELECTRONICS**

1. Addition/Subtraction of binary numbers.

2. Multiplexer/Demultiplexer Circuits.

3. Encoder/Decoder Circuits.

4. Timer Circuits, Shift Registers, Binary Comparator Circuits.

**MICROPROCESSORS**

5. Addition and Subtraction of 8-bit and 16-bit numbers.

6. Sorting of Data in Ascending & Descending order.

7. Sum of a given series with and without carry.

8. Greatest in a given series & Multi-byte addition in BCD mode.

9. Interface programming with 4 digit 7 segment Display & Switches & LED’s.

10. 16 Channel Analog to Digital Converter & Generation of Ramp, Square, Triangular wave by Digital to Analog Converter.

**AVIONICS DATA BUSES**

11. Study of Different Avionics Data Buses.

12. MIL-Std – 1553 Data Buses Configuration with Message transfer.

13. MIL-Std – 1553 Remote Terminal Configuration.

**Note: At least Eight Experiments should be performed. Out of that Two Experiments may be performed or designed and set by the concerned institute as per the scope of the syllabus.**

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AER-405A** | **PROJECT – III** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Practical** | **Total** | **Time** |
| **0** | **0** | **10** | **5** | **0** | **100** | **100** | **200** | **3h** |
| **Purpose** | **To familiarize the students with the applications of engineering problems as a minor project.** |
| **Course Outcomes** |
| **CO1** | **Enhancement of analytical capability of students for real time engineering problems.** |
| **CO2** | **Understand Methodologies and professional way of Documentation and Communication** |
| **CO3** | **Extend or use the idea on major project** |
| **CO4** | **To implement presentation techniques in their work style** |

The students expected to take up a project under the guidance of teacher from the college. The project must be based on (Aeronautical Engineering / Mechanical Engineering) problems, which can be extended up to the full academic session. The students may be asked to work individually or in a group not more than four students.

Students need to submit a model which can be a physical working model or simulation based virtual model with a full preliminary report in a proper format as instructed by Project Guide. Viva- Voce must be based on the preliminary report submitted by students related to the project.

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|  | **B.Tech. (7thSemester) Aeronautical Engineering** |
| **AER-407A** | **INDUSTRIAL TRAINING – III** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major****Test** | **Minor****Test** | **Practical** | **Total** | **Time****(Hrs.)** |
| **2** | **0** | **0** | **--** | **--** | **100** | **--** | **100** |  |
|  |  |
| **Purpose** | To provide comprehensive learning platform to students where they can enhance their employability skills and exposure to the industrial environment. |
| **Course Outcomes** |
| **CO1** | Capability to acquire and apply fundamental principles of engineering. |
| **CO 2** | Become updated with all the latest changes in technological world. |
| **CO 3** | Capability and enthusiasm for self-improvement through continuous professional development and life-long learning |
| **CO 4** | Awareness of the social, cultural, global and environmental responsibility as an engineer. |

**Note:** AER-407A is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone after 6th semester and students will be required to get passing marks to qualify.

The candidate has to submit a training report of his/her work/project/assignment completed in the industry during the training period. The evaluation will be made on the basis of submitted training report and viva-voce/presentation.

**Elective Subjects for 7th Semester Aeronautical Engineering Students**

In **7th Semester**, there will be three electives, **OPEN ELECTIVE – I**, **PROGRAM ELECTIVE – III**, **PROGRAM ELECTIVE – IV**.

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| **OPEN ELECTIVE – I**  |
| **Course Code** | **Course Title** |
| AEO-401A | Flight Dynamics |
| AEO-403A | Aircraft Communication and Navigation Systems |
| AEO-405A | Experimental Aerodynamics |
| AEO-407A | Microprocessor and Interfacing |

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| **PROGRAM ELECTIVE – III**  |
| **Course Code** | **Course Title** |
| AEP-401A | Principles of Helicopter Engineering |
| AEP-403A | Boundary Layer Theory |
| AEP-405A | Aircraft Maintenance of Power Plant and Systems |
| AEP-407A | Fuels and Propellant Technology |

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| **PROGRAM ELECTIVE – IV**  |
| **Course Code** | **Course Title** |
| AEP-409A | Computational Fluid Dynamics |
| AEP-411A | Finite Element Methods |
| AEP-413A | Aircraft Maintenance of Airframe and Systems |
| AEP-415A | Ergonomics in Aerospace |

\**The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.*

**OPEN ELECTIVE – I**

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|  | **B. Tech (7th Semester) Aeronautical Engineering** |
| **AEO-401A** | **FLIGHT DYNAMICS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the advanced concepts of flight dynamics and stability** |
| **Course Outcomes** |
| **CO1** | **Understanding the performance analysis of aircraft** |
| **CO2** | **Introduction to the principles of load factor and turn criteria** |
| **CO3** | **Understanding the concept of longitudinal stability** |
| **CO4** | **Introduction to the advanced lateral and directional stability** |

**Unit-I**

Range and Endurance of Propeller and Jet aircrafts, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- Effect of design parameters for propeller and jet aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight

**Unit-II**

Take-off and landing performance, Turning performance, bank angle and load factor, Constraints on load factor, Pull up and pull down maneuvers, maximum turn rate, V-n diagram.

**Unit-III**

Criteria for longitudinal static stability, contribution to stability by wing, tail, fuselage, wing fuselage combination, Total longitudinal stability, Neutral point-Stick fixed and Stick free aspects, Free elevator factor, static margin, Hinge moment, longitudinal control, Movement of centre of gravity, elevator control power, elevator angle to trim, elevator angle per g, maneuver point, Stick force gradient and stick force per g, Aerodynamic balancing Aircraft Equations of motion, small disturbance theory, Phugoid motion, Factors affecting the period and damping

**Unit-IV**

Directional stability-yaw and sideslip, contribution to static directional stability by wing, fuselage, vertical tail, Power effects on directional stability-propeller and jet aircrafts, Rudder lock and Dorsal fin, Directional control, rudder control power, rudder requirements, adverse yaw, asymmetric power condition, spin recovery, Lateral stability-Dihedral effect, contribution of various components, lateral control, aileron control power, strip theory, roll control by spoilers, aileron reversal, aileron reversal speed

**Text Books:**

1. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 2012.

2. Houghton,E.L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Amold Publishers, 2000

**Reference Books:**

1. Nelson, R.C.” Flight Stability & Automatic Control”, McGraw Hill, 2005

2. Perkins C.D. &Hage R.E. “Airplane performance, stability and control”, John Wiley & Sons 1976

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEO-403A** | **AIRCRAFT COMMUNICATION AND NAVIGATION SYSTEMS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the techniques of communication and navigation** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of communication features** |
| **CO2** | **Introduction to the principles of pulse modulation and its transmission** |
| **CO3** | **Understanding the concept of propagation of signals**  |
| **CO4** | **Introduction to the advanced frequency systems** |

**Unit-I**

Information: Communication systems: signals, analogue, digital and coded forms, time and frequency representation, signal spectra, types of distortion

Information: Nature and measure, influence of bandwidth and signal/noise ratio on channel capacity, elements of Shannon's theorem and its implications. Problems of communicating in presence of noise.

Modulation: Amplitude, angle and phase modulations, single and vestigial sideband forms, demodulation, Super heterodyne principle, automatic gain and frequency control, typical circuit arrangements

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**Unit-II**

Pulse modulation: Sampling principles, sampling criterion, quantisation and quantisation noise,selection of number and distribution of quantisation levels, bandwidth requirements, examples ofcoding and decoding circuits.

Transmission: Transmission lines and their circuit representation, characteristic impedance, complex propagation constant, standing wave radio, matching and impedance charts.

ChannelPerformance: Amplitude and phase distortion, phase and group delay distortion caused bymultiple effects. Noise, origin, measurements, noise figure and noise temperature effecton channel performance. Frequency and time division multiplexing.

**Unit-III**

Radiation: Principles: application of basic formulae for unipole and dipole, aerials,effective height, directional, properties, gain, impedance, linear arrays, traveling waveaerials, rhombicas, parasitic elements. Propagation: Principles: influence of ionosphere andtroposphere reflection from earth's surface, field strength calculations, fading diversity reception.

**Unit-IV**

Special Systems (Principles) : VHF, UHF, Fibre optics and Laser Technology, Satellitecommunication and related equipment, electronic counter measures, low-level TV andHead-down displays, CR T displays, Direction finding. Air borne telemetry systems. Laserand infrared systems, Air data and flight recording systems.Satellite communication, spread spectrum technology: satellite transponders, earthterminals.

**Text Books:**

1. F E Terman, Radio Engineering, McGraw Hill

2. E C Jordon, Electromagnetic Waves and Radiating System, Prentice Hall

3. B P Lathi, Communications Systems, John Wiley and Sons

**Reference Books:**

1. Prasad, Antenna and Propagation

2. Schwattz Bennet MWR and Stein S, Communication Systems and Techniques, McGraw Hill, NY

3. Carlson A. N., Communication Systems - An Introduction to Signals and Noise

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEO-405A** | **EXPERIMENTAL AERODYNAMICS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To familiarize students with the experimental techniques of aerodynamic testing**  |
| **Course Outcomes** |
| **CO1** | **Understanding the low speed wind tunnel testing** |
| **CO2** | **Understanding the high speed wind tunnel testing** |
| **CO3** | **Understanding the pressure, velocity and temperature measurement in wind tunnel** |
| **CO4** | **Introduction to the computation techniques** |

**Unit-I**

Low speed wind tunnels-Power losses in wind tunnel, energy ratio, Calibration, Flow angularity,Yaw Sphere, Yaw meter, Turbulence sphere, Pressure sphere, Wind tunnel balances, boundary correction, calculation of CL and CDforairfoils.

**Unit-II**

High Speed wind tunnels- Blow down, Induction Type Tunnels, Losses in supersonic tunnels, Second throat, running time estimation, Hypersonic, transonic tunnels, Shock tunnels, Gun tunnels

**Unit-III**

Pressure measurement, Hot wire anemometer, laser Doppler anemometer for turbulence and velocity measurements-Temperature measurement, Measurement of wall shear stress, Rotameters and Ultrasonic flow meters.

**Unit-IV**

Smoke tunnel, Tuft method, chemical coating, interferometer, Schlieren and Shadowgraph method, Heleshaw Apparatus, Hydraulic analogy, limitations of analogy, Measurement systems, data acquisition, signal conditioning, multiplexing, data conversion, uncertainty analysis

**Text Book:**

1. Rathakrishnan. E “Instrumentation, Measurement and Experiments in Fluids”, CRCPress, London, 2000

**Reference Books:**

1. Rae W.H and Pope. A “Low speed wind tunnel testing” John Wiley Publication, 1999

2. Pope. AandGoin. L “High speed wind tunnel testing” John Wiley, 1985

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEO-407A** | **MICROPROCESSOR AND INTERFACING** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the advanced concepts of microprocessors used in Avionics** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of 8086 Architecture** |
| **CO2** | **Introduction to the principles of 8086 microprocessor programming** |
| **CO3** | **Understanding the concept of memory system design** |
| **CO4** | **Introduction to the input output interfacing techniques** |

**Unit-I**

**INTRODUCTION:** Evolution of microprocessors, technological trends in microprocessor development. The Intel family tree. CISC versus RISC. Applications of Microprocessors.

**8086 CPU ARCHITECTURE:** 8086 Block diagram; description of data registers, address registers; pointer and index registers, PSW, Queue, BIU and EU. 8086 Pin diagram descriptions. Generating 8086 CLK and reset signals using 8284. WAIT state generation. Microprocessor BUS types and buffering techniques, 8086 minimum mode and maximum mode CPU module.

**Unit-II**

**8086 INSTRUCTION SET:** Instruction formats, addressing modes, Data transfer instructions, string instructions, logical instructions, arithmetic instructions, transfer of control instructions; process control instructions; Assembler directives. **8086 PROGRAMMING TECHNIQUES:** Writing assembly Language programs for logical processing, arithmetic processing, timing delays; loops, data conversions. Writing procedures; Data tables, modular programming. Macros.

**Unit-III**

**MAIN MEMORY SYSTEM DESIGN:** Memory devices, 8086 CPU Read/Write timing diagrams in minimum mode and maximum mode. Address decoding techniques. Interfacing SRAMS; ROMS/PROMS.

Interfacing and refreshing DRAMS. DRAM Controller – TMS4500.

**Unit-IV**

**BASIC I/O INTERFACE:** Parallel and Serial I/O Port design and address decoding. Memory mapped I/O Vs Isolated I/O Intel’s 8255 and 8251- description and interfacing with 8086. ADCs and DACs, - types, operation and interfacing with 8086. Interfacing Keyboards, alphanumeric displays, multiplexed displays, and high power devices with 8086. **INTERRRUPTS AND DMA:** Interrupt driven I/O. 8086 Interrupt mechanism; interrupt types and interrupt vector table. Intel’s 8259. DMA operation. Intel’s 8237. Microcomputer video displays.

**Text Books:**

1. D.V.Hall , Microprocessors and Interfacing , McGraw Hill 2nd ed.

2. J Uffenbeck , The 8086/8088 family , (PHI).

**Reference Book:**

1. Liu,Gibson , Microcomputer Systems – The 8086/8088 family, (2nd Ed-PHI).

**Program Elective-III**

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEP-401A** | **PRINCIPLES OF HELICOPTER ENGINEERING** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the advanced concepts of rotor aerodynamics and stability** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of rotor blade motion** |
| **CO2** | **Understanding the concept of Actuator Disk Theory** |
| **CO3** | **Understanding the concept of Forward Flight Theory** |
| **CO4** | **Introduction to the stability of rotor and its embedded vibrations** |

**Unit-I**

Historical development of helicopter and overview, Basic concepts, Introduction to hovering and forward flight theory, Rotor blade motion – flapping, feathering and lagging motion, Composite structures.

**Unit-II**

The actuator-disc theory, Working states of rotor, Optimum rotor, Efficiency of rotor, Ground effect on lifting rotor, The effect of finite number of blades, Induced velocity and induced power in forward flight – Mangler and Squire method, flight and wind tunnel test, The vortex wake, Aerofoil characteristics in forward flight.

**Unit-III**

Blade forces and motion in forward flight, Force, torque and flapping coefficient, Helicopter trim analysis, Performance in forward flight.

**Unit-IV**

Longitudinal and lateral stability, Equations of motion, Stability characteristics, Auto stabilization,

Control response.

Exciting forces, Fuselage response, Vibration absorbers, Measurement of vibration in flight.

**Text Books:**

1. Helicopter Dynamics: Bramwell, A.R.S.

2. Principles of Helicopter Engineering: Jacob Shapiro

**Reference Book:**

1. Aerodynamics of Helicopter, Gessow, A, and Myers GC

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEP-403A** | **BOUNDARY LAYER THEORY** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the advanced concepts of boundary layer theory** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of boundary layer theory** |
| **CO2** | **Understanding the concept of Navier Stokes Equation** |
| **CO3** | **Understanding the solution of Navier Stokes Equation** |
| **CO4** | **Introduction to the turbulent boundary layer concept** |

**Unit-I**

Basic laws of fluid flow- Continuity, momentum and energy equations as applied to system and control volume –Concept of flow fields- Viscous fluid flow with historical out lines of viscous flow, Boundary conditions for viscous flow problems, Development of boundary layer- Prandtl’s hypothesis, Estimation of boundary layer thickness- Displacement thickness, momentum and energy thickness for two-dimensional flows. Viscosity and thermal conductivity, thermodynamic properties.

**Unit-II**

General stress system in a deformable body, the rate at which the fluid element is strained in a flow, Relation between stress and rate of deformation, Stoke’s hypothesis, bulk viscosity and thermodynamic properties, The Navier – Stokes Equation (N-S) –General properties of Navier – Stokes Equation.

Two dimensional flow through a straight channel. Hagen- Poiseulle flow, suddenly accelerated plane wall, Stagnation in plane flow (Hiemenz problem), Flow near a rotating disk, Very slow motion, Parallel flow past a sphere.

**Unit-III**

Analysis of flow past a flat plate and a cylinder, Integral relation of Karman, Integral analysis of energy equation, Laminar boundary layer equations, Flow separation. Similarity solutions for steady two dimensional flows; Blasius solution for flat- plate flow, Boundary layer temperature profiles for constant wall temperature, Falkner Skan Wedge flows, Free shear flows- plane laminar jet, plane laminar wake. Integral equation of Boundary layer, Karman-Pohlhausen method. Digital computer solutions. Thermal boundary layer calculations- One parameter (U0 and two parameters (U0 and ΔT) integral methods. Stability of laminar flows

**Unit-IV**

Two dimensional turbulent boundary layer equations, Integral relations, Eddy-Viscosity theories, Velocity profiles; the law of the wall, the law of the wake. Turbulent flow in pipes and channels. Turbulent boundary layer on a flat pate, Boundary layers with pressure gradient.

Introduction to the compressible boundary layer on a flat plate, shock wave boundary layer interaction.

**Text Books:**

1. Viscous Fluid Flow 3rd Ed. Frank M White McGraw Hill 2006

2. Boundary Layer theory 6th Ed. H. Schlichting McGraw Hill 1968

**Reference Book:**

1 Aerodynamics for Engineers 4th Ed. John Bertin Pearson 2004

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEP-405A** | **AIRCRAFT MAINTENANCE OF POWERPLANT AND SYSTEMS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the maintenance of Powerplant and aircraft systems** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of Piston Engines** |
| **CO2** | **Understanding the concept of Propellers and aviation fuel** |
| **CO3** | **Understanding the concept of Superchargers and Gas Turbine** |
| **CO4** | **Introduction to the concept of Engine Maintenance** |

**Unit-I**

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.

**Unit-II**

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.

**Unit-III**

Common methods of checking contamination. Sources of contamination, Ignition 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: Induction, exhaust and cooling systems, Anti Icing of engine, engine mountings, thrust augmentation. Compressor surge and stall, bleed control system. Principles of operation.

**Unit-IV**

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, and 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.

**Text 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

**Reference Books:**

1. Pratt and Whitney, Gas Turbine Engine

2. Michacl J. Krose Thomas W.Wild, Bent, Aircraft Power Plants, McGraw Hill 1994

3. H Cohen, G F C Rogers and H I H Sarvanmutto, Gas Turbine Theory, John Wiely

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

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEP-407A** | **FUELS AND PROPELLANT TECHNOLOGY** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the properties of aviation fuels and rocket propellants** |
| **Course Outcomes** |
| **CO1** | **Providing the knowledge of aviation turbine fuels** |
| **CO2** | **Understanding the concept of liquid propellants** |
| **CO3** | **Introduction to concept of cryogenic propellants** |
| **CO4** | **Experimental studies of propellant properties** |

**Unit-I**

Properties and tests for petroleum products - Motor gasoline - Aviation gasoline - Aviation turbine fuels - Requirements of aviation turbine fuels of Kerosene type and high flash point type - Requirements for fuel oils Single base propellants - Double base propellants – composite propellants - CMDB propellants – Metalized composite Propellants - Brief introduction to combustion theory of composite and double base propellants

**Unit-II**

Various liquid propellants and their properties - Monopropellant and bipropellant systems - Concept of ullage - Ignition studies of liquid propellants - Propellant loading tolerances - Inventory-Volume versus mass loading - Loading measurement and control - Outage control

**Unit-III**

Introduction to cryogenic propellants - Liquid Hydrogen, liquid Oxygen, Liquid nitrogen and liquid helium - Theory behind the production of low temperature - Expansion Engine – Cascade process - Joule Thompson Effect - Magnetic effect - Ortho and Para H2 - Hilium4 and Helium3 - Ideal cycles and Efficiency of cryo systems - Storing of cryogenic propellants - Cryogenic loading problems

**Unit-IV**

Laboratory testing - Arc Image Furnace - Ignitability studies - Differential Thermal Analysis - Thermo gravimetric analysis - Particle size measurement Micro-merograph - Strand burner tests Impulse Bomb - Performance estimation

**Text Books:-**

1. Sutton, G.P., Rocket Propulsion Elements, John Wiley, 1993.

2. Sharma, S.P. and Mohan. C., Fuels and Combustion, Tata McGraw Hill Publishing Co., Ltd., 1984

**Reference Book:-**

1. Mathur, M. and Sharma. R.P., Gas Turbines and Jet and Rocket Propulsion, Standard Publishers, New Delhi, 1988

**Program Elective – IV**

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEP-409A** | **COMPUTATIONAL FLUID DYNAMICS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the numerical methods to solve fluid problems** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of equilibrium equation** |
| **CO2** | **Understanding the concept of Finite Difference and control volume** |
| **CO3** | **Understanding the concept of Boundary conditions used in discretisation** |
| **CO4** | **Introduction to the SIMPLE algorithm to find solutions** |

**Unit-I**

Methods of prediction: comparison of experimental investigation Vs theoretical calculation; Mathematical description of physical phenomena; significance of governing differential equations; the general form of governing differential equation. Classification of problems: Physical classification: Equilibrium problems and Marching problems; Mathematical classification: Elliptic, parabolic and hyperbolic partial differential equations; Nature of co-ordinates; one way and two-way co-ordinates; Proper choice of co-ordinates.

**Unit-II**

The concept of discretisation; Finite differences; Taylor series formulation; Finite difference discretisation of ordinary and partial derivatives; Truncation error, round-off error, discretization error; Consistency and stability of numerical schemes; Variation formulation; Method of weighted Residuals, control volume formulation.

**Unit-III**

Steady one- dimensional Conduction, The inter-face conductivity, Non linearity, Source-Term Linearization, Types of Boundary Conditions. Unsteady one-dimensional Conduction: Explicit, Crank-Nicolson and Fully Implicit scheme's Discretisation of two and threedimensional problems, Stability analysis.

**Unit-IV**

Steady one dimensional convection and diffusion, The up wind scheme, Generalized Formulation, Discretisation equation for two and three dimensional problems, The outflow Boundary condition, false Diffusion. Basic difficulty, Vorticity Based methods, Representation of the continuity equation, the staggered grid: the momentum equations, the pressure velocity corrections, and SIMPLE algorithm.

**Text Book:**

1. Computational Fluid Dynamics - By Anderson, McGraw-Hill

**Reference Book:**

1. Numerical Heat Transfer and fluid flow- By Patankar, McGraw-Hill

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEP-411A** | **FINITE ELEMENT METHODS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the finite element methods to solve advance structural problems** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of finite element modelling** |
| **CO2** | **Understanding the concept of potential energy approach** |
| **CO3** | **Understanding the concept of Stiffness Matrix** |
| **CO4** | **Introduction to the solution of axisymmetric problems** |

**Unit-I**

Introduction to FEA - historical background - Review of various approximate methods – Raleigh Ritz’s, Galerkin and finite difference methods- Governing equation and convergence criteria of finite element method, Examples of Finite Element Modeling

**Unit-II**

Direct stiffness method – spring element- Derivation of the stiffness matrix- Example of a spring assemblage Assembly of global stiffness matrix-Types of boundary conditions- The Potential energy approach, Examples Prismatic bar under axial loading- bending of beams, Fundamentals of Finite Element Modeling, Element Division - Numbering Scheme, Coordinate and Shape Functions, The Potential Energy Approach, Assembly of Global Stiffness Matrix and Load Vector, Treatment of Boundary Conditions, Temperature Effects, Shear Force and Bending Moment, Examples.

**Unit-III**

Plane truss structure: Introduction, Plane Trusses, Coordinate Transformation, Local & Global Coordinate, the Element Stiffness Matrix- Stress Calculations, Temperature Effects –Examples. Plane stress & strain – Constant Strain Triangle (CST)- Iso - parametric Representation- Potential Energy Approach - Element Stiffness; Force Terms Stress Calculations- Temperature Effects- Examples

**Unit-IV**

Axisymmetric formulation – Element stiffness matrix and force vector – Galerkin approach – Body forces and temperature effects – Stress calculations – Boundary conditions and Nodal Solution; Mapping and Numerical Integration– Four node quadrilateral for axisymmetric problems –Applications to cylinders under internal or external pressures – Rotating discs

**Text Books:**

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu,”Introduction to Finite Elements in Engineering”, Prentice Hall India,Fourth Edition, 2011.

2. Rao. S.S., “Finite Element Methods in Engineering”, Butterworth and Heinemann, Fourth Edition, 2005.

**Reference Books:**

1. Reddy J.N.,”An Introduction to Finite Element Method “, McGraw Hill, 3rd edition, 2005.

2. Krishnamurthy, C.S., “Finite Element Analysis”, Tata McGraw Hill, 2nd 2001.

3. Bathe, K.J. and Wilson, E.L., “Numerical Methods in Finite Elements Analysis”, Prentice Hall of India, 1985.

4. Robert D Cook, David S Malkus, Michael E Plesha, “Concepts and Applications of Finite Element Analysis”, John Wiley and Sons, Inc., Fourth edition, 2001.

5. Larry J Segerlind, “Applied Finite Element Analysis”, John Wiley and Sons, Inc. Second Edition, 1984

6. Daryl L. Logan, “A First Course in the Finite Element Method”, 5th Edition, PWS Publishing Company, Boston, 2010.

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEP-413A** | **AIRCRAFT MAINTENANCE OF AIRFRAME AND SYSTEMS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the maintenance of airframe and aircraft systems** |
| **Course Outcomes** |
| **CO1** | **Introduction to the aircraft structure parts** |
| **CO2** | **Introduction to the concept of Honeycomb Construction** |
| **CO3** | **Understanding the concept of aircraft systems used in structures** |
| **CO4** | **Introduction to the inspection techniques in aircraft systems** |

**Unit-I**

Airframe Structure: Various types of structures in aiframe construction, tubular, braced monocoque, semimonocoque, etc, longerons, stringers, formers, bulkhead, spars and ribs,

**Unit-II**

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.

**Unit-III**

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.

**Unit-IV**

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 in Airframe maintenance, 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.

**Text 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. Michael J. Kroes and James R Faren, Aircraft Basic Science, McGraw Hill

**Reference Books:**

1. Michael J. Kroes and William A Watkins, Aircraft Maintenance and Repair, McGraw Hill

2. Civil Aircraft Inspection Procedures (CAP 459) Pt II Aircraft, Himalayan Books

3. Airframe and Power Plant Mechanic (AC 65-15A) Airframe Hand Book, Himalayan Books.1991

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|  | **B. Tech (7thSemester) Aeronautical Engineering** |
| **AEP-415A** | **ERGONOMICS IN AEROSPACE** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the workplace design in aerospace industry** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of ergonomics** |
| **CO2** | **Understanding the concept of technology in ergonomics** |
| **CO3** | **Understanding the concept of design and simulation in ergonomics** |
| **CO4** | **Introduction to the case studies related to ergonomics** |

**Unit-I**

Basic Principles of Ergonomics, Anthropometry, Posture and Health; Anthropometry Practical; Displays, Controls and HMI; Tools and Equipment Design; Workplace Design and Assessment; Task Analysis; Questionnaire and Interview Design; Product Design and Evaluation; Designing for manufacture and maintenance; Health and Safety Legislation and Ergonomics.

**Unit-II**

Application of Ergonomics Principles, Cognitive Ergonomics, Human Information Processing; Memory; Reading; Perception; Navigation; Problem Solving; Decision Making, Human-Computer Interaction, Input/Output Technology, Usability; Evaluation; Health problems.

**Unit-III**

Future Systems, Job Design, Scientific Management, Enrichment, Enlargement, Rotation, Cells, Shift work, Management Style and Job Design, Change Management. New Technology, Unemployment, Deskilling, Introducing new technology. Questionnaire design and assessment. Task analysis techniques. Measurement of human error and risk. Use of simulation and prototypes. Product Evaluation. Experimental Design

**Unit-IV**

Case Studies: A set of case studies will be used to demonstrate how ergnomics has led to changes in work activity, safety and product design. Case studies will include advanced computer applicatons, workplace assessment and re-design, accident analysis and industrial inspection, and in manufacturing. Students will be required to apply the principles to a real life ergonomic design as applied to a product, service or computer application.

**Text Books:**

1. Work Design: Industrial Ergonomics – Knoz, Stephan A., Johnson, Steven, Holcomb Hathaway, Scottsdale, AZ.

2. Human factors in engineering and design – Sanders, M.S. & McCormick, E.J., 6th ed., McGraw-Hill, New York.

**Reference Books:**

1. Ergonomics: Man in his working environment- Murrell, K.F.H, Champan& Hall, and London.

2. Man – Machine Engineering – Chapanis A: Wordsworth Publishing Co.

3. The Practice and Management of Industrial Ergonomics – Alexander, D.C., Prentice-Hall, Englewood Cliffs, NJ

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AER-402A** | **PROJECT – IV** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Practical** | **Total** | **Time** |
| **0** | **0** | **10** | **5** | **0** | **100** | **100** | **200** | **3h** |
| **Purpose** | **To familiarize the students with the applications of engineering problems as a major project.** |
| **Course Outcomes** |
| **CO1** | **Demonstrate a through and systematic understanding of project contents.** |
| **CO 2** | **Understand methodologies and professional way of documentation and communication.** |
| **CO 3** | **Know the key stages in development of the project** |
| **CO 4** | **Extend or use the idea in real life applications** |

The students expected to take up a project under the guidance of teacher from the college. The project must be based on (Aeronautical Engineering / Mechanical Engineering) problems, which can be extended up to the full academic session. The students may be asked to work individually or in a group not more than four students.

Students need to submit a model which can be a physical working model or simulation based virtual model with a full preliminary report in a proper format as instructed by Project Guide. Viva- Voce must be based on the preliminary report submitted by students related to the project.

**Elective Subjects for 8th Semester Aeronautical Engineering Students**

In **8th Semester**, there will be four electives, **OPEN ELECTIVE – II**, **OPEN ELECTIVE – III, PROGRAM ELECTIVE – V**, **PROGRAM ELECTIVE – VI**

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| **OPEN ELECTIVE – II** |
| **Course Code** | **Course Title** |
| AEO-402A | Wind Tunnel Techniques |
| AEO-404A | Robotics and Automation |
| AEO-406A | Computer Aided Design |
| AEO-408A | Product Design and Manufacturing |

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| **OPEN ELECTIVE – III** |
| **Course Code** | **Course Title** |
| AEO-410A | Rockets and Missiles |
| AEO-412A | Introduction to Automatic Flight Control |
| AEO-414A | Aerospace Power Electronics |
| AEO-416A | Non-Destructive Testing |

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| **PROGRAM ELECTIVE – V**  |
| **Course Code** | **Course Title** |
| AEP-402A | Space Dynamics |
| AEP-404A | Aircraft Quality Control, Quality Assurance and Certification |
| AEP-406A | Aircraft Systems and Instrumentation |
| AEP-408A | Theory of Vibrations |

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| **PROGRAM ELECTIVE – VI**  |
| **Course Code** | **Course Title** |
| AEP-410A | Air Transportation and Aircraft Maintenance Management |
| AEP-412A | Aircraft Modeling and Simulation |
| AEP-414A | Control Theory and Practices |
| AEP-416A | Mechatronics |

\**The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section*

*.***OPEN ELECTIVE – II**

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEO-402A** | **WIND TUNNEL TECHNIQUES** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the wind tunnel experimental techniques** |
| **Course Outcomes** |
| **CO1** | **Introduction to the test section and other parts of wind tunnel** |
| **CO2** | **Introduction to the concept of parameter measurement** |
| **CO3** | **Understanding the concept of wind tunnel balances** |
| **CO4** | **Introduction to the applications of wind tunnel** |

**Unit-I**

Test section, diffuser, fan section, fan design, return passage, cooling, The breather- vibration, test section flow quality, diffuser design, wind tunnel construction, energy ratio, final form.

**Unit-II**

Measurement of pressure, velocity, turbulence, flow angularity, hot wire anemometry, laser velocimeter, data acquisition, flow visualization techniques, wind tunnel calibration.

**Unit-III**

Wind tunnel balances- Internal & External balances, design of wind tunnel balances, Wake survey method.

Method of Images, boundary corrections, buoyancy corrections, wake blockage, solid blockage- (2D & 3D corrections).

**Unit-IV**

Applications in wind engineering, Surface vehicle testing, testing of buildings for wind forces, pollution, other applications at low Reynolds numbers.

**Text Book:**

1. Low speed wind tunnel testing:W.E.Rae and A.Pope, John Wiley 1985.

**Reference Book:**

1. Measurement of Airflow Pankhrust and Ower ,Pergamon Press

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEO-404A** | **ROBOTICS AND AUTOMATION** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with robotics and automation applications in aerospace** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of construction of types of robots and its parts** |
| **CO2** | **Introduction to the principles of sensor technology** |
| **CO3** | **Understanding the concept of automation and its levels** |
| **CO4** | **Introduction to the automated flow lines** |

**Unit-I**

Introduction. Construction of manipulators, advantages and disadvantages of various kinematic structures. Applications, Non-servo robots, motion planning. Feedback systems, encoders Kinematics, homogeneous coordinates solution of the inverse kinematic problem, multiple solutions, jacobian, work envelopes. Trajectory planning. Joint Interpolated Trajectory, Link joints and their Manipulator dynamics and force control. Sensors: Vision, ranging, laser, acoustic, tactile.

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**Unit-II**

Developments in sensor technology, sensory control. Programming Language: VAL, RAIL, and AML. Mobile robots, walking devices. Robot reasoning

**Unit-III**

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

**Unit-IV**

Automated Flow lines, Methods of Workpart Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines

**Text Book:**

1. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.

**Reference Book:**

1. “Automation, Production Systems and Computer Integrated Manufacturing”- M.P.Grover, Pearson Education.

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEO-406A** | **COMPUTER AIDED DESIGN** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To familiarize students with the computer aided design concepts used in aerospace** |
| **Course Outcomes** |
| **CO1** | **Understanding the types of lines, projections and transformations** |
| **CO2** | **Understanding the design of curves, surfaces and solids** |
| **CO3** | **Understanding the numeric control programming** |
| **CO4** | **Introduction to the group technology and flexible systems** |

**Unit-I**

Introduction to CAD/CAM, Historical developments, Industrial look at CAD/CAM, Introduction to CIM; Basics of geometric and solid modeling, explicit, implicit, intrinsic and parametric equations, coordinate systems.

Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations, orthographic and perspective projections, reconstruction of 3-D objects.

**Unit-II**

Curves: Algebraic and geometric forms, tangents and normal, blending functions re-parametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves.

Surfaces: Algebraic and geometric forms, tangents and normal, blending functions, re-parametrization, sixteen point form, four curve form, plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, biezer surface, B-spline surface.

Solids: Solid models and representation scheme, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration

**Unit-III**

Automation and Numerical Control: Introduction, fixed, programmable and flexible automation, types of NC systems, MCU and other components, NC manual part programming, coordinate systems, G & M codes, Part program for simple parts, computer assisted part programming.

**Unit-IV**

Group Technology: Part families, part classification and coding, production flow analysis, Machine cell design, Advantages of GT

Flexible Manufacturing Systems & Computer aided process planning: Introduction, FMS components, types of FMS, FMS layouts, planning for FMS, advantages and applications Coventional process planning, types of CAPP, Steps in variant process planning, planning for CAPP.

**Text Books:**

1. CAD/ CAM by Groover and Zimmer, Prantice Hall.

2. CAD/ CAM Theory and Practice by Zeid, McGraw Hill

3. Numerical Control and Computer Aided Manufacturing by Kundra, Rao & Tiwari, TMH.

**Reference Books:**

1 CAD/CAM (Principles, Practice & Manufacturing Management) by Chirs Mc Mohan & Jimmie Browne, Published by Addison- Wesley.

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEO-407A** | **PRODUCT DESIGN AND MANUFACTURING** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the concept of product design and its manufacturing** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of product development** |
| **CO2** | **Introduction to the principles of design process** |
| **CO3** | **Understanding the planning for manufacturing and its management** |
| **CO4** | **Introduction to the intellectual property rights regarding product design** |

**Unit-I**

**INTRODUCTION:** Product Development – Characteristics, Duration, Challenges, Organizations. Development Process– Processes, Process Flow. Product Planning – Identifying Opportunities, Prioritization, Resource allocation and Pre-Project Planning. Customer Needs – Data gathering, Organizing Needs.

**CONCEPT DEVELOPMENT:** Product and Target specification, various steps in concept generation, Brainstorming, Morphological analysis, Selection of Concepts – Subjective decision-making, Criteria ranking, Criteria weighting, Datum method, EVAD (Design Evaluation) method, Principles of Computer aided decision making

**Unit-II**

**DESIGN PROCESS:** Concept Testing – Survey, Response and Interpretation. Product Architecture, Platform planning, System level design issues. Embodiment design - Introduction, Size and strength, Scheme drawing, Form design, Provisional material and process determination, Design for assembly and manufacture, Industrial design. Modeling - Introduction, Mathematical modeling, Optimization, Scale models, Simulation.

**Unit-III**

**PLANNING FOR MANUFACTURE AND MANAGEMENT:** Detail Design - Factor of safety, Selection procedure for bought out components, Material Selection, Robust design, Experimental Plan. Design Management - Management of design for quality, Project planning and control, Production design specification (PDS), Quality function deployment (QFD), Design review, Value analysis/engineering

**Unit-IV**

**INTELLECTUAL PROPERTY RIGHTS AND PROJECT ECONOMICS:** Intellectual Property Rights – Introduction, Study prior inventions, Write the description of the invention, Refine Claims, Pursue application. Economics and Management – Financial Model, Project Trade – Off, Accelerating Projects, Project Execution.

**Text Book:**

1. Dieter G E, ―Engineering Design‖, McGraw – Hill, 2009.

**Reference Book:**

1. A K Chitale, R C Gupta, ―Product Design and Manufacturing‖, Prentice Hall of India, 2009

**OPEN ELECTIVE – III**

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEO-410A** | **ROCKETS AND MISSILES** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the advanced concepts of propulsion in Rockets and Missiles** |
| **Course Outcomes** |
| **CO1** | **Understanding the combustion system used in solid rockets** |
| **CO2** | **Introduction to the principles of burnout velocity approximations and estimation** |
| **CO3** | **Understanding the concept of solid rocket motors** |
| **CO4** | **Introduction to the advanced trajectory analysis and introduction to electric propulsion** |

**Unit-I**

**Classification of Rockets and Missiles**-Differences-Uses-Advantages and Disadvantages. Ignition system in Rockets - Types of igniters - Igniter design considerations – Design consideration of liquid rocket combustion chamber, injector propellant feed lines, valves, Propellant tanks outlet and helium Pressurized and turbine feed systems - Propellant slosh and propellant hammer - Elimination of geysering effect in missiles .

**Combustion system of solid rockets:**Airframe components of rockets and missiles - Forces acting on a missile while passing through atmosphere - Method of describing aerodynamic forces and moments - Lateral aerodynamic moment – Lateral Damping moment and longitudinal moment of a rocket - Lift and drag forces – Drag

**Unit-II**

**Estimation** - body up wash and downwash in missiles - rocket dispersion – Numerical problems. One dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields - Description of vertical, inclined and gravity turn trajectories - Determination of range and altitude

**Simple Approximations to burnout velocity: -**Rocket vector control - Methods - Thrust termination - SITVC - Multistage of rockets – Vehicle optimization - Stage separation dynamics - Seperation techniques.

**Unit-III**

**Selection of materials** - Special requirements of materials to perform under adverse conditions.

**Solid Rocket Motors:** General description, interior ballistics component design Techniques.

**Unit-IV**

**Liquid Rocket Engines:** General description, engine cycles, power balance calculation, component design fundamentals.

**Electric Propulsion:** Classification of electric propulsion systems.

**Trajectory Analysis:** The rocket equation, vertical trajectories, multistage rockets, generalized 2D trajectory

**Text Books:**

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

2. Mathur, M., and Sharma, R.P., "Gas Turbines and Jet and Rocket Propulsion ", Standard Publishers, New Delhi, 1998.

**Reference Books:**

1. Cornelisse, J.W.., "Rocket Propulsion and Space Dynamics ", J.W., Freeman & Co., Ltd., London, 1982.

2. Parket, E.R., "Materials for Missiles and Spacecraft ", McGraw Hill Book Co., Inc., 1982

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEO-403A** | **INTRODUCTION TO AUTOMATIC FLIGHT CONTROL** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To familiarize students with the concept of automatic flight control** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of control system and types of controllers** |
| **CO2** | **Introduction to the principles of frequency response analysis** |
| **CO3** | **Understanding the concept of stability of control systems** |
| **CO4** | **Introduction to the digital control system** |

**Unit-I**

Introduction And Applications: Types of control systems ; Typical Block Diagram : Performance Analysis; Applications – Machine Tool Control, Boiler Control, Engine Governing, Aerospace Control, Active Vibration Control; Representation of Processes & Control Elements – Mathematical Modeling. Block Diagram Representation, Representation of Systems or Processes, Comparison Elements; Representation of Feedback Control systems – Block Diagram & Transfer Function Representation, Representation of a Temperature, Control System, Signal Flow Graphs, Problems.

Types of Controllers: Introduction, Types of Control Action; Hydraulic Controllers; Electronic Controllers; Pneumatic Controllers; Problems.

**Unit-II**

Transient And Steady State Response: Time Domain Representation; Laplace Transform Representation; System with Proportional Control; Proportional – cum – Derivative control; Proportional – cum – Integral Control; Error Constants; Problems.

Frequency Response Analysis: Introduction; Closed and Open Loop Transfer Function; Polar Plots; Rectangular Plots; Nichols Plots: Equivalent Unity Feed Back Systems; Problems.

**Unit-III**

Stability of Control Systems: Introduction; Characteristic Equation; Routh’s Criterion; Nyquists Criterion, Gain & Phase Margins: Problems.

Root Locus Method : Introduction; Root Ioci of a Second Order System; General Case; Rules for Drawing Forms of Root Ioci; Relation between Root Locus Locations and Transient Response; Parametric Variation; Problems..

**Unit-IV**

Digital Control System : Introduction; Representation of Sampled Signal; Hold Device; Pulse Transfer Function; Block Diagrams; Transient Response; Routh’s Stability Criterion; Root Locus Method; Nyquists Criterion; Problems.

State Space Analysis Of Control Systems: Introduction; Generalized State Equation; Techniques for Deriving System State – Space Equations; Transfer Function from State Equations; Solution of State Vector Differential Equations; Discrete Systems; Problems.

**Text Books:**

1. Theory & Applications of Automatic Controls by B.C. Nakra, Published by New Age International Pvt. Ltd. Publishers, New Delhi.

2. Modern Control Engg. ByUgata, Prentice Hall of India, New Delhi. 69

**Reference Books:**

1. Automatic Control Systems by Kuo’ Published by Prentice Hall of India, New Delhi.

2. Control System Engineering, I. J. Nagrath and M. Gopal, New Age, New Delhi.

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEO-405A** | **AEROSPACE POWER ELECTRONICS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To familiarize students with the power electronics concept used in aerospace applications** |
| **Course Outcomes** |
| **CO1** | **Understanding the concept of power electronics** |
| **CO2** | **Introduction to the concept of thyristor and its analysis** |
| **CO3** | **Understanding the concept of Phase controlled converters** |
| **CO4** | **Introduction to the AC Voltage Controllers** |

**Unit-I**

Power Semiconductor Devices: Introduction, Concept of Power Electronics, scope and applications, desired Characteristics of controllable switches Power semiconductor switches and their characteristics: Power Diode, Power BJT, Power MOSFET, IGBT, SCR, TRIAC, and GTO.

**Unit-II**

**Thyristor:** Rating & protection, Methods of SCR commutation, Gate Drive Circuit, Series and Parallel operation.DC-DC Converters:Introduction, Control Strategies, Buck converter, Boost Converter, Buck-Boost converter, Analysis of buckconverter, Switched Mode power Supply (SMPS).

**Unit-III**

**Phase Controlled Converters:**Single phase half wave controlled rectifier with various loads, Effect of free- wheeling diode. Single phase fully controlled and half controlled bridge converters with various loads. Performance Parameters of single phase uncontrolled and controlled converters.
Three phase half wave converters, three phase fully controlled and half controlled bridge converters, Effect
of source impedance, Single phase and three phase dual converters

**Unit-IV**

**AC Voltage Controllers:** Principle of On-Off and phase controls, Single phase ac voltage controller with resistive and inductive loads,sequence control, Introduction to Matrix converter. Cyclo Converters:
Basic principle of operation, single phase to single phase, three phase to single phase output voltage equation.

**Text Books:**1. M.H. Rashid,“Power Electronics: Circuits, Devices & Applications”, Pearson India, 4th Edition,2018.
2. Ned Mohan, T.M.Undeland and W.P.Robbins, “Power Electronics: Converters, Applications and Design”, Wiley India
3. P.C. Sen, “Power Electronics”, McGraw Hill Education (India) Pvt. Ltd.
4. P.S. Bhimbra, “Power Electronics”, Khanna Publishers.

**Reference Books:**1. M.S. Jamil Asghar, “Power Electronics” Prentice Hall of India Ltd., 2004
2. Chakrabarti&Rai, “Fundamentals of Power Electronics &Drives”, Dhanpat Rai & Sons.
3. V.R. Moorthy, “PowerElectronics: Devices, Circuits and Industrial Applications” Oxford University Press,2007

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEO-407A** | **NON DESTRUCTIVE TESTING** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To familiarize students with the non-destructive testing methods used in aerospace applications** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of non-destructive testing methods** |
| **CO2** | **Introduction to the principles of testing procedure and types of methods** |
| **CO3** | **Understanding the concept of Thermography method** |
| **CO4** | **Introduction to the Eddy current Testing Method** |

**Unit-I**

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, various physical characteristics of materials and their applications in NDT Visual inspection – Unaided and aided.

**Unit-II**

Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

**Unit-III**

Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications.

**Unit-IV**

Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

**Text Books:**

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.

2. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010

**Reference Books:**

1. ASM Metals Handbook,”Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.

2. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005

3. Charles, J. Hellier,“ Handbook of Nondestructive evaluation”, McGraw Hill, New York 2001.

4. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

**PROGRAM ELECTIVE – V**

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEP-402A** | **SPACE DYNAMICS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To study basics of space and astrodynamics and conceptual overview of celestial orbits.** |
| **Course Outcomes** |
| **CO1** | **To impart the knowledge in two-body, restricted three-body and n-body problem, Hamiltonian dynamics, canonical transformations, Poincare surface sections.** |
| **CO2** | **To offer a rigorous vector analysis of rotational kinematics, review of the basic Newtonian dynamics and analysis of spacecraft altitude dynamics.** |
| **CO3** | **To provide necessary knowledge to study the satellite and interplanetary trajectories and formal approaches for handling coordinate transformations.** |
| **CO4** | **To solve the space dynamic problems related to earth satellite orbits using Hamilton‘s and generate interplanetary orbits in the frame work of restricted three-body problem.** |

**Unit-I**

**INTRODUCTION TO SPACE DYNAMICS**

Basic concepts: Atmospheric and space flight basic definitions, vector operations; Coordinate systems and rotation matrix, Euler axis and principal angle, Euler angles, Euler symmetric parameters (Quaternion), Rodriguez parameters, attitude kinematics

**Unit-II**

**FUNDAMENTALS OF SPACE FLIGHT**

Newton ‘s law of gravitation, gravitational potential, escapes velocity, mechanics of circular orbits and circular velocity non circular orbits; The two-body problem, derivation of Kepler ‘s laws from Newton ‘s law.

**Unit-III**

**SPACE FLIGHT ORBITS AND ATMOSPHERE ENTRY**

Orbit equation, space vehicle trajectories, transfer orbit changes. Introduction to earth and planetary entry, equations of motion for atmosphere entry; Application to ballistic entry, case study.

**Unit-IV**

**ORBIT TRANSFER**

Coplanar transfer, Hohmann transfer and Bielliptic transfer; Orbital change due to impulsive thrust; Non-coplanar transfer; Interception and Rendezvous, continuous thrust transfer.

**ATTITUDE DYNAMICS**

Euler Equations of rotational motion, rotational kinetic energy; Principal body frame, torque free rotation of spacecraft, spacecraft with attitude thrusters, spacecraft with rotors, gravity gradient satellite, dual spin satellite.

**Text Books:**

1. Ashish Tewari, ―Atmospheric and space flight dynamics‖Birkhauser publications, 1st Edition, 2007

2. Vallado, David A., ―Fundamentals of Astrodynamics and Applications‖, Kluwer Academic Publishers, London, 3rd Edition, 2007.

**Reference Books:**

1. Roy, Archie E., ―The Foundation of Astrodynamics‖, The Macmillan Company, Collier Macmillan Limited, London, 3rd Edition, 2007.

2. Kaplan, Marshall H., ―Modern Spacecraft Dynamics and Control‖, John Wiely& Sons, New York, 1st Edition, 1976.

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEP-404A** | **AIRCRAFT QUALITY CONTROL, QUALITY ASSURANCE AND CERTIFICATION** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To familiarize students with Quality control concepts used in Aerospace Industry** |
| **Course Outcomes** |
| **CO1** | **To monitoring each phase of the design process** |
| **CO2** | **To acquire the analytic ability for attention to detail and a systematic thought process.** |
| **CO3** | **To review documentation related to both internal and external manufacturing processes to ensure quality products.** |
| **CO4** | **To develop, register and use problem analysis to proactively identify quality process solutions** |

**Unit-I**

Reversible and irreversible flight control systems. Flying qualities of aircraft-relation to airframe transfer function. Pilot's opinion ratings. Flying quality requirements- pole-zero, frequency response and time response specifications. Displacement and rate feedback determination of gains conflict with pilot input s resolution-control augmentation systems- Full authority fly-by-wire. Auto Pilot-Normal acceleration, Turn rate, Pitch rate Commands-Applications.

**Unit-II**

Maintenance Procedures: Maintenance planning; Modification procedures; Stores procedures; Certification/release procedures; Interface with aircraft operation; Maintenance Inspection/Quality Control/Quality Assurance; Additional maintenance procedures; Control of life limited components

**Unit-III**

Bearings: Introduction and function of bearings, loads, material, construction; Types of bearings and their application. Testing, cleaning and inspection of bearings; Lubrication requirements of bearings; Defects in bearings and their causes. 11 Transmissions: Gear types and their application; Gear ratios, reduction and multiplication gear systems, driven and driving gears, idler gears, mesh patterns; Belts and pulleys, chains and sprockets. Inspection of gears, backlash; Inspection of belts and pulleys, chains and sprockets; Inspection of screw jacks, lever devices, push-pull rod systems

**Unit-IV**

General knowledge of ground handling of Aircraft, Aircraft Safety; Mooring, Jacking, Levelling, hoisting of aircraft, Towing, Mooring of an a/c during adverse conditions. Aircraft cleaning and maintaining. Ground signaling/marshalling of aircraft in day and night time. 19 Part-IV Maintenance and handling of ground equipment’s used in maintenance of aircraft. Compressors, Portable hydraulic test stands, Electrical power supply equipment, charging trolley. Air-conditioning and Heating unit, Ground support air start unit. Pressure oil unit, Fire extinguishers, jacks, Hoisting cranes/gantry, Ladders, Platforms, Trestles, and Chocks.

**Text Books:**

1. Airframe and Powerplant Mechanics (AC 65-15A)-Airframe Hand Book FAA.

2. Civil Aircraft Inspection Procedure (CAP 459) Part II Aircraft.

**Reference Books:**

1. Aircraft Maintenance and Repair ByKroes, Watkin and Delph.

2. Acceptable Methods, Techniques and practices (FAA)-EA-AC 43.13-1 A and2 A.

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEP-406A** | **AIRCRAFT SYSTEMS AND INSTRUMENTATION** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce the concepts of aircraft systems and the instruments used in aerospace industry** |
| **Course Outcomes** |
| **CO1** | **Impart the knowledge in various types of Avionics systems, its components & its applications in aerospace industries.** |
| **CO2** | **Offer a rigorous avionics technology, Review of the basic system integration and the different type of avionics architectures** |
| **CO3** | **Provide necessary knowledge to study the aircraft instrumentation sensors, displays and different type of sensors.** |
| **CO4** | **Give knowledge about military aircraft adaptation, avionics and mission system interface and gives the difference between civilian aircraft avionics and military aircraft avionics.** |

**Unit-I**

**AIRPLANE CONTROL SYSTEMS**

Flight control systems- primary and secondary flight control conventional systems; Power assisted and fully powered flight controls; Power actuated systems; Engine control systems; Push pull rod system, flexible push full rod system; Control linkages, actuation- types, description and redundancy. Components; Modern control systems; Digital fly by wire systems, control laws, implementation; Auto pilot system.

**Unit-II**

**MILITARY AIRCRAFT ADAPTATION**

Avionic and mission system interface, navigation and flight management; Navigation aids, flight deck displays, communications, aircraft systems; Applications, personnel, material and vehicle transport, air-to-air refueling, maritime patrol, airborne early warning, ground surveillance; Electronic warfare, the EW spectrum, electronic support measures, electronic countermeasures, electro-optics and the infra-red.

**Unit-III**

**AIRCRAFT INSTRUMENTATION - SENSORS AND DISPLAYS**

Air data sensors, magnetic sensing, inertial sensing, and radar sensors. The electromechanical instrumented flight deck, early flight deck instruments, attitude direction indicator, horizontal situation indicator, altimeter, airspeed indicator; Advanced flight deck display system architectures, display systems, display media, future flight deck displays.

**Unit-IV**

**AIRBORNE RADAR, ASTRIONICS - AVIONICS FOR SPACECRAFT**

Propagation of Radar waves, functional elements of radar, antenna- transmitter; Types of radar- pulse Doppler, civil aviation applications, military applications; Attitude determination and control of spacecraft, magnetometers, sun sensors, star trackers, earth and horizon sensors; Command and telemetry

**Text Book:**

1. Hirst, M., The Air Transport System, Woodhead Publishing Ltd, Cambridge, England, 2008.

**Reference Books:**

1. Wensven, J.G., Air Transportation: A Management Perspective, Ashgate, 2nd Edition 2007.

2. Belobaba, P., Odoni, A. and Barnhart, C., Global Airline Industry, 2nd Edition Wiley, 2009.

3. M. Bazargan, M., Airline Operations and Scheduling, Ashgate, 1st Edition 2004.

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|  | **B. Tech (8thSemester) Aeronautical Engineering** |
| **AEP-408A** | **THEORY OF VIBRATIONS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To familiarize the students about the concepts of vibrations of aircraft structures** |
| **Course Outcomes** |
| **CO1** | **Impart the knowledge in various types of Avionics systems, its components & its applications in aerospace industries.** |
| **CO2** | **Offer a rigorous avionics technology, Review of the basic system integration and the different type of avionics architectures** |
| **CO3** | **Provide necessary knowledge to study the aircraft instrumentation sensors, displays and different type of sensors.** |
| **CO4** | **Give knowledge about military aircraft adaptation, avionics and mission system interface and gives the difference between civilian aircraft avionics and military aircraft avionics.** |

**Unit-I**

**SINGLE-DEGREE-OF-FREEDOM LINEAR SYSTEMS**

Introduction to theory of vibration, equation of motion, free vibration, response to harmonic excitation, response to an impulsive excitation, response to a step excitation, response to periodic excitation (Fourier series), response to a periodic excitation (Fourier transform), Laplace transform (Transfer Function).

**Unit-II**

**TWO-DEGREE-OF-FREEDOM SYSTEMS**

Introduction, Equations of Motion for Forced Vibration, Free Vibration Analysis of an Undamped System, Torsional System, Coordinate Coupling and Principal Coordinates, Forced-Vibration Analysis, semi definite Systems, Self-Excitation and Stability Analysis, Transfer- Function Approach, Solutions Using Laplace Transform, Solutions Using Frequency Transfer Functions.

**Unit-III**

**MULTI-DEGREE-OF-FREEDOM LINEAR SYSTEMS**

Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi- rotor systems and geared systems; Discrete- Time systems.

**Unit-IV**

**INTRODUCTION TO AEROELASTICITY**

Static Aeroelasticity; Typical Section Model of an Airfoil: Typical Section Model with Control Surface, Typical Section Model—Nonlinear Effects. One Dimensional Aeroelastic Model of Airfoils: Beam-Rod Representation of Large Aspect Ratio Wing, Eigenvalue and Eigen function Approach, Galerkin‘s Method. Dynamic Aeroelasticity; Hamilton ‘s Principle: Single Particle, Many Particles, Continuous Body, Potential Energy, Non potential Forces, Lagrange ‘s Equations.

**Text Books:**

1. Bismarck-Nasr, M.N., ―Structural Dynamics in Aeronautical Engineering‖, AIAA Education Series, 2nd Edition, 1999.

2. Rao, S.S., ―Mechanical Vibrations‖, Prentice-Hall, 5th Edition, 2011.

3. Earl H. Dowell, ―A Modern Course in Aeroelasticity‖ Volume 217, Duke University, Durham, NC, USA.

**Reference Books:**

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, ―Aeroelasticity‖, Addison Wesley Publishing Co., Inc., 2nd Edition, 1996.

2. Leissa, A.W., Vibration of continuous system, The McGraw-Hill Company, 2nd Edition, 2011.

3. Inman, D.J., Vibration Engineering, Prentice Hall Int., Inc., 3rd Edition, 2001.

**PROGRAM ELECTIVE – VI**

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|  | **B. Tech (8th Semester) Aeronautical Engineering** |
| **AEP-410A** | **AIR TRANSPORTATION AND AIRCRAFT MAINTENANCE MANAGEMENT** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To understand the procedures for various segments of aircraft operations and various issues involved during the airline operations.** |
| **Course Outcomes** |
| **CO1** | **Understand complexity and transport operation systems.** |
| **CO2** | **Understand many transport issues involved in handling passengers, freight of aircraft.** |
| **CO3** | **Understand the economics behind the aviation industry** |
| **CO4** | **Understand the application of ATC and RADAR Systems in Airport Management** |

**Unit-I**

**AVIATION INDUSTRY**

Introduction, history of aviation, evolution, development, growth, challenges; Aerospace industry, air transportation industry- economic impact, types and causes; Airline industry, structure and economic characteristics; Airlines as oligopolists, other unique economic characteristics; Significance of airline passenger load factors.

**Unit-II**

**AIRCRAFT MANAGEMENT**

Costs- project cash-flow, aircraft price; Compatibility with the operational infrastructure; Direct and indirect operating costs; Balancing efficiency and effectiveness-payload-range, fuel efficiency. Technical contribution to performance, operating speed and altitude, aircraft field length performance; Typical operating costs; Effectiveness- wake-vortices, cabin dimensions, flight deck.

**Unit-III**

**AIRPORTS AND AIRLINES**

Setting up an airport: airport demand, airport sitting, runway characteristics, length, declared distances, aerodrome areas, obstacle safeguarding; Runway capacity, evaluating runway capacity, sustainable runway capacity; Setting up an airline, modern airline objectives; Route selection and development, airline fleet planning, annual utilization and aircraft size, seating arrangements; Indirect operating costs; Aircraft- buy or lease; Revenue generation, computerized reservation systems, yield management; Integrating service quality into the revenue-generation process; Marketing the seats; Airline scheduling; Evaluating success, financial viability, regulatory compliance, efficient use of resources, effective service

**Unit-IV**

**AIRSPACE**

Categories of airspace, separation minima, airspace sectors, capacity, demand and delay; Evolution of air traffic control system, procedural ATC system, procedural ATC with radar assistance, first generation ‗automated‘ ATC system, current generation radar and computer-based ATC systems; Aerodrome air traffic control equipment and operation - ICAO future air-navigation systems (FANS); Air-navigation service providers as businesses.

**Text Book:**

1. Fundamentals of Air Traffic Control, 4th Edition, Michael S. Nolan, Thomson Brooks/Cole, USA.

**Reference Book:**

1. Planning and Design of Airports, 4th Edition, Robert Horonjeff& Francis X. McKelvey, McGraw Hill Professional Publishing.

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|  | **B. Tech (8th Semester) Aeronautical Engineering** |
| **AEP-412A** | **AIRCRAFT MODELING AND SIMULATION** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To introduce students with the advanced concepts of modeling and simulation in aerospace** |
| **Course Outcomes** |
| **CO1** | **Understanding the basics of mathematical modelling concepts** |
| **CO2** | **Introduction to the applications of mathematical modelling for aircrafts** |
| **CO3** | **Understanding the concept of dynamic models** |
| **CO4** | **Introduction to the simulation models** |

**Unit-I**

**Mathematical Modelling:**Mathematical concepts in Modelling, Why modelling, Goals of modelling studies, Process of Mathematical modeling, Real world problem, falling rock modeling, Computational problem, Basics of curve fittings, Engineering simulations and process of solving engineering problems, Analytical and numerical problem solutions with example.

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**Unit-II**

**Aircraft Modeling:**Aircraft modeling, Aircraft state-space vectors, body-fixed coordinate systems, rotation matrix for wind and stability axes, Aircraft Equation of motion, kinetic equations for translation, kinematic equations for attitude, rigid-body kinetics, sensors and measurement systems, Introduction to Perturbation, Perturbation theory, nominal and perturbation values, Linearization of rigid body kinetics, Linear state-space model based on using wind and stability axes.

**Unit-III**

**Dynamic Models:** Decoupling: longitudinal and lateral modes: Longitudinal and lateral equations, Aerodynamic Forces and Moments, longitudinal and lateral forces and moments, standard aircraft maneuvers, bank to turn, altitude control dynamic models, longitudinal and lateral stability analysis, Satellite modelling, Attitude model

**Unit-IV**

**Simulation models:** Software Simulation of Aircraft dynamics models, 767 longitudinal and lateral model, F-16 Longitudinal and Lateral Mode, F2B Bristol Lateral model

**Text Book:**

1. “Computational Modelling and Simulation of Aircraft and the Environment”: Dominic J. Diston, John Wiley & Sons, Ltd., 2009

**Reference Book**:

1. “Flight Stability and Automatic Control”, R. C. Nelson, McGraw-Hill Book, 1989

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|  | **B. Tech (8th Semester) Aeronautical Engineering** |
| **AEP-414A** | **CONTROL THEORY AND PRACTICES** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To understand and gain knowledge on aircraft control systems and its application.** |
| **Course Outcomes** |
| **CO1** | **Apply stability criteria to determine the stability of an aircraft, and specify the aircraft time-domain and frequency-domain response specifications.** |
| **CO2** | **Understand classical control theory in the frequency domain and modern control theory in the state space are effectively mixed to provide the student with a modern view of systems theory.** |
| **CO3** | **Design control techniques for aircraft control systems, and study some feedback control applications.** |
| **CO4** | **Study the controllability and observability of aerospace systems, and apply the modern control techniques to design enhanced flight control systems.** |

**Unit-I**

**INTRODUCTION TO CONTROL SYSTEMS**

Dynamical systems-principal constituents-input, output-process (plant)-block diagram representation. Inputs- control input, noise. Function of controls regulation (hold), tracking (command)-examples. Measure of effectiveness. Sensitivity of output to control input, noise and system parameters- robustness. Deterministic and stochastic control. The pervasiveness of control in nature, engineering and societal systems. The importance of study of control system. Need for stable, effective (responsive), robust control system. Modeling of dynamical systems by differential equations-system parameters. Examples from diverse fields. First and second order systems, higher order systems, single input single output systems, and multiple-input multiple-output.

**Unit-II**

**MATHEMATICAL MODELLING OF DYNAMIC SYSTEMS**

Control system performance- time domain description- output response to control inputs-- impulse and indicial response- characteristic parameters- significance- relation to system parameters- examples- first and second order linear systems, higher order systems. Synthesis of response to arbitrary input functions from impulse and indicial response. Review of Fourier transforms and Laplace transforms- inverse transforms- significance, applications to differential equations. 's' (Laplace) domain description of input-output relations- transfer function representation- system parameters- gain, poles and zeroes. Characteristic equation- significance- examples. Frequency and damping ratio of dominant poles. Relation of transfer functions to impulse response. Partial fraction decomposition of transfer functions significance

**Unit-III**

**FLYING QUALITIES OF AIRCRAFT**

Reversible and irreversible flight control systems. Flying qualities of aircraft-relation to airframe transfer function. Pilot's opinion ratings. Flying quality requirements- pole-zero, frequency response and time response specifications. Displacement and rate feedback determination of gains conflict with pilot input s resolution-control augmentation systems- Full authority fly-by-wire. Auto Pilot-Normal acceleration, Turn rate, Pitch rate Commands-Applications.

**Unit-IV**

**STEADY STATE RESPONSE ANALYSIS**

System type, steady state error, error constants- overall system stability. Application of feedback in stability augmentation, control augmentation, automatic control-examples. Composition, reduction of block diagrams of complex systems-rules and conventions. Control system components - sensors, transducers, servomotors, actuators, filters-modeling, transfer functions. Single-input single-output systems. Multiple input-multiple output systems, matrix transfer functions-examples. Types of control problems- the problem of analysis, control synthesis, system synthesis- examples- static control of aircraft. Extension to dynamic control. System identification from input output measurements importance.

**Text Books:**

1. Kuo, B.C., ―Automatic Control Systems‖, Prentice Hall India, 1992.

2. Stevens, B.L. and Lewis, F.L., ―Aircraft Control and Simulation‖, John Wiley, 1992.

**Reference Book:**

1. Mc Lean, D., ―Automatic Flight Control Systems‖, Prentice Hall, 1990 J.

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|  | **B. Tech (8th Semester) Aeronautical Engineering** |
| **AEP-416A** | **MECHATRONICS** |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To understand key elements of Mechatronics system, representation into block diagram and concept of transfer function, reduction and analysis.** |
| **Course Outcomes** |
| **CO1** | **Develop a simulation model for simple physical systems and explain mechatronics design process** |
| **CO2** | **Outline appropriate sensors and actuators for an engineering application** |
| **CO3** | **Explain linearization of nonlinear systems and elements of data acquisition** |
| **CO4** | **Explain various applications of design of mechatronic systems** |

**Unit-I**

Introduction, synergy of systems, definition of mechatronics, applications of mechatronics in design and modeling, actuators and sensors, intelligent controls, robotics, manufacturing etc., objectives, advantages and disadvantages of mechatronics, examples of mechatronics systems in industry. Mechanical components in mechatronics, force, friction and lubrication, materials, mechanical behavior of materials, mechanisms used in mechatronics, lever and four bar mechanisms, bearing, belt, chain, cam, slider crank, clutches etc.

**Unit-II**

System modeling and analysis, control system concepts, transfer function of physical systems, block diagrams representation of systems, transfer function of a system, standard input signals, time response of a first and second order systems to a step input, frequency response analysis, automatic control systems, digital control systems. Motion control devices, actuator types & application areas, hydraulic and pneumatic actuators, electrical actuators, DC servomotor, AC servomotor and stepper servomotor, micro-actuators, drive selection and applications.

**Unit-III**

Sensors and transducers, their static and dynamic performance characteristics, internal sensors, external sensors and micro-sensors, sensors for displacement, position and proximity; velocity, motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensors, selection of Sensors. Stages in designing mechatronics systems, traditional and mechatronic design, possible design solutions, case studies of mechatronics systems, pick and place robot, automatic car park systems, engine management systems etc.

**Unit-IV**

Mechatronics in industry, autotronics, bionics and avionics and their various applications, mechatronics in manufacturing, features of mechatronics in manufacturing, flexible manufacturing systems, manufacturing automatic protocol, computer integrated manufacturing, just in time production systems, CNC machines, adaptive control machine system, CNC machine operations, challenges in mechatronics production units.

**Text Book:**

1. A Kuttan, “Introduction to Mechatronics, Oxford University Press, 2010.

**Reference Book:**

1. Alciatore&Histand, “Introduction to Mechatronics & Measurement Systems, 4e”, McGrawHill Education, 2014.