

SCHEME OF EXAMINATION
B.TECH. 4th Year Aeronautical Engineering -7th Semester

Course No.	Course Title	Teaching Schedule				Examination schedule			Total Marks	Duration of Exam
		L	T	P/D	Total	Theory	Sessional	Practical/Viva		
-----	Department Elective-I	3	1	-	4	100	50	-	150	3
-----	Department Elective-II	3	2	-	5	100	50	-	150	3
ARE 401E	Helicopter Dynamics	3	1	-	4	100	50	-	150	3
ARE 403E	Airplane Design	3	1	-	4	100	50	-	150	3
ARE 405E	Avionics	4	1	-	5	100	50	-	150	3
ARE 407E	Aircraft Maintenance Lab	-	--	3	3	-	25	25	50	3
ARE 409E	Avionics Lab	-	-	3	3	-	25	25	50	3
ARE 411E	Minor Project	-	-	7	7	-	100	100	200	3
ARE 413E	Practical Training Report	-	-	-	-	-	125	-	125	3
	TOTAL	16	6	13	35	500	525	150	1175	-

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DEPARTMENT ELECTIVE-I

ARE-415E Aircraft Maintenance of Airframe and Systems
ARE 417E Fuels & propellant Technology
ARE 419E Compressible Aerodynamics

DEPARTMENT ELECTIVE-II

ARE-421E Aircraft Rules and Regulations
ARE-423E Aircraft Maintenance of Powerplant and Systems

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B. Tech. (Seventh Semester) Aeronautical Engineering

**Helicopter Dynamics
ARE-401E**

L	T	P	Sessional	:	50 Marks
3	1	-	Theory	:	100 Marks
			Total	:	150 Marks
			Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-1

ELEMENTARY BLADE MOTION

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-2

AERODYNAMICS OF THE ROTOR IN MOTION

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-3

HELICOPTER TRIM AND PERFORMANCE IN MOTION

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

UNIT-4

DYNAMIC STABILITY AND CONTROL

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

HELICOPTER VIBRATIONS

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

References:-

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

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B. Tech. (Seventh Semester)Aeronautical Engineering
Airplane Design
ARE-403E

L	T	P	Sessional	:50 Marks
3	1	-	Theory	:100 Marks
			Total	:150 Marks
			Duration of Exam.	: 3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

Introduction

Aircraft design, requirements and specifications, airworthiness requirements. Weight: It's importance. Aerodynamic and structural design considerations. Classifications of airplane, Concept of configuration, features of special purpose airplanes. Unmanned aerial vehicles and their features.

Air Loads in Flight

Classical methods of estimating symmetrical maneuvering loads on a wing in flight, basic flight loading conditions, Load factor, V-n diagram, gust loads, estimation of gust loads, structural effects. use of panel methods to estimate air load distribution on a wing.

UNIT-II

Airplane Weight Estimation

Estimation of airplane weight based on airplane type / mission and material used. trends in wing loading, iterative approach

Wing Design Considerations

Factors influencing selection of airfoil and plan form. Span wise air loads variation with span and planform, stalling, take-off and landing considerations. BM and SF. Design principles for the structure of all metal, stressed skin wing (Civil & Military airplane).estimation of wing drag, effect of flaps.

UNIT-III

Structural Layout And Integration

Structural layout of straight, tapered swept (fwd and aft) wings. fuselage, empennage, Engine locations, Cockpit and passenger cabin layout, layout of flight and engine controls.wing-fuselage jointing methods, all metal airplane considerations, use of composite materials. Preparation of 3- views .CG location.

UNIT-IV

Landing Gears

Requirement of landing gears, different arrangements, mechanism for retraction into fuselage and wing. absorption of landing loads, calculations of loads.

Airframe Power plant integration

Estimation of Horizontal and vertical tail volume ratios, number of engines, location for inlets and considerations their of. Revised CG location.

Text Books:

1. Airplane Design- A Conceptual Approach: Daniel P Raymer.
2. Design of Airplane: D.Stinton

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References:

1. Fundamentals of Aircraft Design: L.M.Nikolai

B. Tech. (Seventh Semester) Aeronautical Engineering

Avionics

ARE-405E

L	T	P	Total
4	1		5

Sessional	: 50 Marks
Theory	: 100 Marks
Total	: 150 Marks
Duration of Exam:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

INTRODUCTION TO AVIONICS

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

PRINCIPLES OF DIGITAL SYSTEMS

Digital Computers – Microprocessors – Memories

DIGITAL AVIONICS ARCHITECTURE

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

UNIT-III

FLIGHT DECK AND COCKPITS

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

INTRODUCTION TO AVIONICS SYSTEMS

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, 1990.

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3. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
 4. 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, 1993

B. Tech. (Seventh Semester) Aeronautical engineering
Aircraft Maintenance Lab
ARE-407E

L	T	P	Sessional	:	25 Marks
0	0	3	Practical	:	25 Marks
			Total	:	50 Marks
			Duration of Exam.	:	3 Hrs.

List of experiments

1. Study of standard operating procedures of safely in aircraft maintenance.
2. Ground running precautions and carry out checks on gas turbine and air intakes prior and after the ground run with the fibroscope
3. Carry out Engine oil system replenishment.
4. Carry out Hydraulic oil system replenishment / checks by CM-20 and patch kit for contamination.
5. Air / oxygen charging procedure and precautions during charging.
6. Study of Mooring, Lashing and picketing procedures.
7. Crack detection with NDT checks – Magnetic, eddy current and vibro acoustic techniques.
8. Inhibition / deinhibition of Aero engines.

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. (Seventh Semester) Aeronautical engineering
Avionics Lab
ARE-409E

L T P
0 0 3

Sessional: 25 Marks
Practical: 25 Marks
Total: 50 Marks
Duration of Exam: 3 Hours

LIST OF EXPERIMENTS
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: 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. (Seventh Semester) Aeronautical Engineering
Minor Project
ARE 411 E

P/D	Total
7	7

Practical Viva: 100 Marks
Sessional : 100 Marks
Total : 200 Marks
Duration of Exams. : 03 hours

The students expected to take up a project under the guidance of teacher from the college. The project must be based on 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 in a group. Viva- voce must be based on the preliminary report submitted by students related to the project.

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**B. Tech. (Seventh Semester) Aeronautical Engineering
Practical Training Report
ARE 413 E**

P/D **Total**
- -

Sessional : 125 marks
Duration of Exams. : 03 hours

Student will submit summer training (about 8 weeks' industrial training) report for his/her assessment.

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**Electives I and II Seventh Semesters
(Aeronautical Engineering)**

**ELECTIVE – I
(For Aeronautical Engineering Students)**

DEPARTMENT ELECTIVE-I

- ARE-415E Aircraft Maintenance of Airframe and Systems.
- ARE 417E Fuels & propellant Technology
- ARE-419E Compressible Aerodynamics

DEPARTMENT ELECTIVE-II

- ARE-421E Aircraft Rules and Regulations
- ARE-423E Aircraft Maintenance of Powerplant and Systems

Elective - I & II will be offered as departmental elective for Aeronautical Engineering Students.

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DEPARTMENT ELECTIVE-I

B. Tech. (Seventh Semester) Aeronautical Engineering Aircraft Maintenance of Airframe and Systems.

ARE 415 E

L T P T
3 1 - 4

Sessional: 50 marks
Theory: 100 marks
Total : 150 Marks
Duration of Exam: 3 hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

Airframe Structure: Various types of structures in airframe 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 exits. Reliability and redundancy of systems design.

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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 Fardn, Aircraft Basic Science, McGraw Hill

References:

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. (Seventh Semester) Aeronautical Engineering
Fuels & propellant Technology
ARE 417 E

L T P
3 2 -

Sessional: 50 marks
Theory : 100 marks
Total : 150 Marks
Duration of Exam: 3 hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

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 - Helium4 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.

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**B. Tech. (Seventh Semester) Aeronautical Engineering
Compressible Aerodynamics**

ARE 419 E

L T P
3 2 -

Sessional: 50 marks
Theory: 100 marks
Total : 150 Marks
Duration of Exam: 3 hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT – I

Shock Waves

Introductory remarks, point source in a compressible flow, Mach waves and shock waves.

1. Normal Shock waves: equation of motion for a normal shock, normal shock relations for a perfect gas, stagnation conditions, RH relations, propagating shock waves, weak shock, reflected shock wave, centered expansion waves, shock tube. Numerical examples
2. Oblique Shock waves: Introduction, oblique shock relations, M - θ relations, shock polar, supersonic flow over wedge, weak oblique shock, supersonic compression, detached shock. Numerical examples.

UNIT-II

Expansion waves

Supersonic expansion by turning, Prandtl-Meyer flow, Numerical problems. Simple and non simple regions, reflection and intersection of shocks and expansion waves, Mach reflections, Method of characteristics, numerical examples

UNIT-III

Lift and drag in supersonic flows:

Shock –Expansion theory, flow field in supersonic, flowfield in supersonic flows, numerical problems, thin airfoil theory, analytical determination of lift and drag coefficients on flat plate, biconvex, and diamond shaped sections in supersonic flows, numerical problems, supersonic leading and trailing edges.

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UNIT-IV

Potential equation for compressible flows:

Introduction, Crocco's theorem, derivation of basic potential equation for compressible flows, linearization of governing equation, boundary conditions, small perturbation theory, application to wavy wall, bodies of revolution.

Introduction, linearized compressible flow, airfoils in subsonic flow, Prandtl-Glauert transformation, critical Mach number, supercritical flows, airfoils in transonic flow, governing equations, shock wave boundary layer interaction, stability and control problems.

Rayleigh's supersonic Pitot formula, Equipment used in supersonic flows, supersonic wind tunnels, heat transfer tunnels, shock tunnels, Aero-ballistic ranges, terminal ballistic range, rocket sled facility, special instrumentation for these types of tunnels.

Text Books:

1. Aerodynamics and thermodynamics of compressible fluid flow: Shapiro A.H., Vols I & II

REFERENCES:

1. Elements of Gas Dynamics : Lieppmann and Rosheko ,John Wiley 1957
2. Modern compressible Flow with historical perspective: John D. Anderson
3. Experimental Methods in Hypersonic flows: J. Lucasiewicz.

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DEPARTMENT ELECTIVE-II

B. Tech. (Seventh Semester) Aeronautical Engineering **Aircraft Rules and Regulations** ARE 421 E

L	T	P	Sessional	:	50 Marks
3	2	-	Theory	:	100 Marks
			Total	:	150 Marks
			Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

C.A.R. SERIES 'A' – PROCEDURE FOR CIVIL AIR WORTHINESS REQUIREMENTS AND RESPONSIBILITY OPERATORS Vis-à-vis AIR WORTHINESS DIRECTORATE

Responsibilities of operators / owners- Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations and safety oversight of engineering activities of operators.

C.A.R. SERIES 'B' – ISSUE APPROVAL OF COCKPIT CHECK LIST, MEL, CDL: Deficiency list (MEL & CDL); Preparation and use of cockpit checklist and emergency list.

UNIT-II

C.A.R. SERIES 'C' – DEFECT RECORDING, MONITORING, INVESTIGATION AND REPORTING

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method.

UNIT-III

C.A.R. SERIES 'D' – AND AIRCRAFT MAINTENANCE PROGRAMMES

Reliability Programmes (Engines); Aircraft maintenance programme & their approval; On condition maintenance of reciprocating engines; TBO – Revision programme; Maintenance of fuel and oil uplift and consumption records – Light aircraft engines; Fixing routine maintenance periods and component TBOs – Initial & revisions.

C.A.R. SERIES 'E' – APPROVAL OF ORGANISATIONS

Approval of organizations in categories A, B, C, D, E, F, & G - Requirements of infrastructure at stations other than parent base.

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C.A.R. SERIES 'F' – AIR WORTHINESS AND CONTINUED AIR WORTHINESS: Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

UNIT-IV

C.A.R. SERIES 'L' & 'M'

Issue of AME Licence, its classification and experience requirements, Mandatory Modifications / Inspections.

C.A.R. SERIES 'T' & 'X'

Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C of A had been previously issued.

Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of tax permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

Text Books:

1. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness)" – Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi 2000.
2. Aeronautical Information Circulars (relating to Airworthiness) from DGCA 2000.
3. "Aircraft Manual (India) Volume" – Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
4. Advisory Circulars from DGCA 2003.

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B. Tech. (Seventh Semester) Aeronautical Engineering

Aircraft Maintenance of Powerplant and Systems

ARE-423E

L T P
3 2

Sessional : 50 Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam: 3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

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 carburetors, 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 : Principle of operation, general constructional details and function of various type of gas turbine engines such as turbojet, turbo fan and by-pass engine.

Theory of gas turbine engines, advantages and disadvantages of each type. Induction,exhaust and cooling systems, anticing of engine, engine mountings, thrust

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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, bleeding and performance checks. Engine on condition maintenance. Trouble shooting and rectification. Inspection after shock landing. Crack detection. Procedure for long and short terms storage of engine and accessories, engine preservation and depreservation.

Text Books :

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

References:

1. Pratt and Whitney, Gas Turbine Engine
2. Michael 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 Wiley
4. Irvine Treager, Aircraft Gas Turbine Engine Technology, Tata McGraw Hill

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