

Aero Science

B.Sc.: Elective

Outlines of Tests

Paper	Title of Course	Marks
A	Aero-engines (Written):	100
B	Navigation (Written):	100
	Total	200

Note: The questions will be set in each paper. Candidates are to attempt any five except in Paper B in which the question on Computers will be compulsory.

Syllabi and Courses of Reading

PAPER A : AERO ENGINE

Course Contents

Reference Material Training Notes and Precise

1. **Gas Dynamics:**
 - a) Continuity Equation—Derivation. AENG-B-I
 - b) Momentum Equation—Derivation.
 - c) Energy Equation—Derivation
 - d) Thrust of a Static Jet Engine—Derivation.
 - e) Thrust of a moving Jet Engine—Derivation.
 - f) Thrust of a Turbofan Engine.
 - g) Engine Performance Parameters.
Definition of:
 - i) Propulsion Efficiency.
 - ii) Thermal Efficiency.
 - iii) Propeller Efficiency
 - iv) Over all Efficiency.
 - h) Derivation of Brequet's Range formula and its analysis.
 - i) Take-off Thrust.
 - j) Specific Fuel Consumption.
 - k) Effective exhaust Velocity.
 - i) Gross Thrust.
 - m) Net Thrust.
 - n) T-S diagram of actual and ideal, Turbo-jet, Efficiencies of Diffuser, Compressor
Turbine and Nozzle, Pressure Ratios of Diffuser Compressor, Combustor
 - o) Characteristics of subsonic and supersonic flow in venturi tube. (Review)
 - p) Shock wave formation (Review).
2. **Ramjet and Pulsejet:**
 - a) Thermodynamic limitations of Turbojet Engine. AENG-B-II
 - b) Operation Principle of Ramjet.
 - c) Subsonic Combustion Ramjet.
 - d) Supersonic Combustion Ramjet (Scram Jet).
 - e) Application of Ramjet.
 - f) Operating Principle of Pulsejet.
 - g) Advantages and disadvantages of Pulsejet.
3. **Intakes:**
 - a) Introduction. AENG-B-III
 - b) Ideal Intake Conditions.
 - c) Flow speed and pressure behind shockwaves.
 - d) Intake Design
 - e) Intake Shape.
 - f) Types of Intake for Supersonic Flight.
 - g) Problems of Supersonic Intake Design.
4. **Compressors:**

- a) Introduction AENG-B-IV
- b) Requirements of a Compressor.
- c) Centrifugal Compressor:
 - i) Introduction.
 - ii) Principles of Operation.
 - iii) Impellers
 - v) Diffuser.
- d) Axial Flow Compressor
 - i) Introduction
 - ii) Construction
 - iii) Principles of Operation.
 - iv) Compressor Stall and surge (only introduction)
- e) Comparison of Axial Flow and Centrifugal Flow Compressor Engines.
 - i) Factors.
 - ii) Material.
- f) Anti stall devices
- g) Effects of stall and Surge.
- 5. **Combustion Chambers:** AENG -B-V
 - a) Introduction.
 - b) Combustion system requirements.
 - c) Flow through typical combustion Chamber.
 - d) Combustion system Layout.
 - e) Combustion Chamber Material and Defects.
 - f) Burners
- 6. **Turbines:** AENG -B-VI
 - a) Introduction
 - b) Turbine Blading.
 - c) Energy transfer from Gas Flow to Turbine
 - d) Vane and Blade profile.
 - e) Turbines operating Conditions.
 - f) Turbine installations.
 - g) Balancing and Testing of Turbines.
 - h) Turbine Faults.
- 7. **Exhaust System.** AENG -B-VII
 - a) Introduction.
 - b) The Exhaust Unit
 - c) The Jet Pipe
 - d) The Nozzle
 - e) Variable Geometry Nozzle
- 8. **Thrust Augmentation:** AENG -B-VIII
 - a) Introduction
 - b) Water injection.
 - c) Re-heat.
 - d) Principles of Re-heat:
 - i) Thrust Production
 - ii) Variation of Nozzle area.
 - iii) Specific Fuel Consumption.
 - e) After Burner Components.
 - f) Re-heat ignition System.
 - g) Re-heat Control
 - h) Choice of ignition and Control System.
- 9. **Thrust Reversal:** AENG-B-IX
 - a) Requirements of Thrust Reversal.
 - b) Layout and Operation of Typical Thrust Reversing System.
 - c) Safety Features.
- 10. **Turboprop and Turbofan Engines:** AENG-B-X

Operating Principles and general characteristics.
- 11. **V / Stoll Engines:** AENG-B-XI
 - a) Power plant Arrangements:
 - i) Composite Power Plant
 - ii) Vectored Thrust
 - b) Engine Types:

- i) Lifting Engines.
 - ii) Vectored Thrust Engines.
- c) Advantages of Lift—Thrust Turbofan.
- d) Large aircraft requirements and Supersonic aircraft requirements.
- 12. **Gas Turbine Fuels:** AENG-B-XII
 - a) General Characteristics
 - b) Vapor pressure.
 - c) Methods of reducing or eliminating fuel losses.
 - d) Aviation turbine fuels, AVTUR-AVTAG-AVCAT.
- 13. **Rocket Motors** AENG-B-XIII
 - a) Rocket performance.
 - b) Solid propellant Rocket Motors
 - i) Main Components.
 - ii) Nozzles and nozzle cooling.
 - iii) Thrust vector control.
 - c) Liquid propellant Rocket Motor:
 - i) Liquid propellant feed systems.
 - ii) Combustion chamber and nozzle
 - iii) Liquid Rocket injectors.
 - d) Introduction to other propulsion system like Nuclear Rockets and Electrical propulsion units.
- 14. **Specific Engine System:** AENG-B-XIV
 - a) Fuel system of MFI-17 Aircraft.
 - b) Fuel system of T-37 Aircraft.
 - c) Hydraulic system of T-37 Aircraft.

Recommended Books

PAPER B : NAVIGATION

1. **Introduction**
 - a) The purpose and importance of aerial Navigation.
 - b) The definition of five types of aerial Navigation i.e.
 - i) Contract of visual.
 - ii) Radio.
 - iii) Radar.
 - iv) Astro.
 - v) Dead. Reckoning.
 - vi) Interial Navigation.
 - c) The dimensious of Navigation.
2. **The Form of Earth**
 - a) The shape of the earth.
 - b) The rotation of the earth.
 - c) The representation of various lines on the surface of the earth and the use of:
 - i) Great circle.
 - ii) Small circle.
 - iii) Meridian.
 - iv) Equators.
 - v) Latitude.
 - vi) Longitude
 - vii) Rhumb Line.
 - d) Position and Comparison of Position:
 - i) Change of Longitude.
 - ii) Change of Latitude.
 - iii) Solution of problems.
3. **Distance and their measurements:**
 - a) Distance measurement:
 - i) Nautical miles.
 - ii) Statute miles.
 - iii) Kilo Meter.
 - b) Inter conversion of Units
4. **Direction on the earth:**
 - a) Angular measurement.

- b) True direction.
 - c) Magnetic direction
 - d) Variation
 - e) Iso gonal
 - f) Compass direction
 - g) Deviation.
 - h) Heading-compass-Magnetic-True (problems)
5. **Elementary Definitions:**
- a) Heading
 - b) Course
 - c) Draft.
 - d) Track.
 - e) Air Speed:
 - i) I.A.S.
 - ii) C.A.S
 - iii) E.A.S.
 - iv) T.A.S.
 - f) Ground speed.
 - g) Bearing
 - h) Relative Bearing
 - i) Ground position.
 - j) Pin Point.
 - k) Fix.
 - l) Height
 - m) Elevation.
 - n) Altitude.
6. **Methods of Reporting Positions:**
- a) The place-name-method-and its illustration
 - b) The bearing distance method
 - c) The latitude and longitude method.
7. **Pressure Instruments**
- a) The Principle, construction and errors of the air speed indicator.
 - b) The Principle, construction and errors of the altimeter.
 - c) The solution of altimeter problems.
 - d) The Principle, construction and errors of V.Y.I
 - e) Conversion of Mach No. to Speed
8. **Map Projections:**
- a) The properties of an ideal projection.
 - b) Stages in map construction
 - c) The types of projections-conical-Azimuthal cylindrical-Mathematical.
 - d) Azimuthal Projection
 - i) Polan Gnomonic.
 - ii) Equitorial Gnomonic
 - iii) Oblique Gnomonic
 - e) Cylindrical Projection
Mercator's Projection
 - f) Topographical projection:
 - i) I.M.P
 - ii) Lamberts conformal.
 - g) Measurement of direction and distance on I.M.P. Lambert's conformal, composite problems.
9. **Map Reading No. 1 & 2:**
- a) The relief on the earth's surface and its representation on a map.
 - b) The representation of scale by:
 - i. Representative fraction.
 - ii. Statement in words.
 - iii. Graduated scale.
 - c) The relative value of ground features on maps.
 - d) Conventional signs on IMP and Lambert's conformal.
 - e) The technique of map reading when visibility is poor and when uncertain of position.
 - f) The technique of map reading at night.

- g) The technique of map reading at low and high level.
10. **Magnetism:**
- Revision of basic theory of magnetism.
 - The earth's magnetic field.
 - The resolution of the earth's magnetic field into components.
 - The effect of components of a magnet.
 - Ali Craft magnetism.
 - The resolution of components of aircraft magnetism.
 - The derivation of co-efficient.
 - The compass swing.
11. **Compass No. 1**
- The B-16 Compass:
 - Construciton.
 - Errors and limitations.
 - Pre-flight check.
 - The J-2 Compass:
 - Construction.
 - Pre-flight checks.
 - Errors and limitations.
 - R.M.I.
12. **Computer**
- The need and purpose of the computer.
 - Solution of:
 - Multiplication and division problems on the computer.
 - Time distance and speed problems.
 - Fuel consumption problems.
 - True Air Speed problems.
 - The attitude problems.
 - Conversion of:
 - Units on the Computer.
 - Speed on Mach No. and vice versa. Computing of heading, drift and ground speed, composite problems.
13. **Last Procedure:**
- Causes of error in Navigation.
 - The procedure of fuel saving to be adopted when uncertain of position.
 - To make use of radio aids if uncertain of position.
 - General lost/procedure.
14. Pilot Navigation:
- Use of the 'One in Sixty Rule'.
 - Sowing the problems of 'One in Sixty Rule' on the Computer.
 - Gain or lose time by:
 - The 'dog leg'.
 - By change of I.A.S.
 - By 'S' turns and 3600
 - Use of position lines for Navigation.
 - Use of radio and radar fixes for Navigation.
15. **Flight Documents:**
- The flight information publication A.F.M 96-5 and its use in flight planning.
 - The high and low level led down charts.
16. **Radio Navigation Adis:**
- The assistance provided by U.D.F station.
 - The use of fixer stations and typed of fixes.
 - Navigation assistance provided by G.C.I. units.
 - Rodio Compass
 - V.O.R.
 - Tacan.
 - G.C.A,
 - I.L.S
17. **Radio Navigation**
- How homing is carried out with the help of Radio Compass.
 - How tracking out is carried out with the help of Radio Compass
 - The distance & time to a radio facility with the help of change of bearing.

- 18. Pre-Flight Planning:**
- a) The importance and need of the following for planning
 - i. Met Briefing.
 - ii. Selection of maps.
 - iii. Selection of Route
 - iv. Method of calculation of safety attitude.
 - v. Medium level and high level separation system.
 - b) The local radio and radar sites.
 - c) The local prohibited danger and restricted areas.
- 19. Flight Planning No.2**
- a) Use of the dash one for flight planning.
 - b) To plan a long Navigation cross country.
 - c) To plan a mission involving climb and descent on track.
- 20. Low level Navigation:**
- a) The problems peculiar to low level missions particularly to high fuel consumption in Jet aircraft.
 - b) To plan a typical low level navigation mission.
 - c) The difficulties involved in recognizing ground features during a low level mission.
- 21. Composite Problems High Attitude Navigation:**
- a) The effect of high wind associated with high attitude.
 - b) The need for calculating mean wind for climb and descent.
 - c) The effect of aircraft speed on drift angle.
- 22. High low High Mission Planning:**
- 23. Tactical Navigation:**
- a) The critical point (C.P.) and its solution by graph and formula.
 - b) The Radius of action problem (ROA) and its solution by graph and prohibited.
 - c) The point of no return (P.N.R) and the difference between P.N.R. and R.O.A
 - d) Searches and reasons (different types of Search)
- 24. Cruise Control:**
- a) Constant Power
 - b) Constant Speed.
 - c) Max. Endurance.
 - d) Max. Range.
- 25. Concept of Celestial Navigation:**
- a) The celestial sphere and its coordinates.
 - b) Rotation and revolution.
 - c) Seasons.
 - d) Celestial coordinates.
 - e) Altitude & Azimuth.
 - f) Celestial fix
- 26. Time:**
- a) the following definite of time:
 - i. Year
 - ii. Day
 - b) The following type of time and their interconversion:
 - i. Local mean time.
 - ii. Greenwich Mean Time.
 - iii. Standard time.
 - iv. Zone Time
 - c) The International Date line.
 - d) The calculation of sunrise and sunset time with the help of A.F.M. 96-5
- 27. Modern Navigation techniques:**
- a) Doppler's Principle.
 - b) Radar P.P.I.
 - c) Inertial Navigation system.
 - d) Omega.
 - e) Astro Tracke