

1. Aero-Science (For P.A.F. College, Sargodha Only) :

2001-2002

APPENDIX 'A'

(Outlines of Tests)

				<i>Marks</i>
<i>Paper 'A'</i> :	Aero-engines (Written) :	100
<i>Paper 'B'</i> :	Navigation (Written) :	100
			Total :	<u>200</u>

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.

APPENDIX 'B'

(Syllabi and Courses of Reading)

Paper 'A' : Aero-engine (Written) :

Note :—The depth and treatment of the topics given below will conform to the relevant material specially published by the P.A.F. College, Sargodha. The Material is referred to below :

<i>S. No.</i>	<i>Topic</i>	<i>Reference Material Training Notes and Precise.</i>
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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.

- (l) Gross Thrust.
- (m) Net Thrust.
- (n) T-S diagram of actual and ideal, Turb-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 :

AENG-B-II

- (a) Thermodynamic limitations of Turbojet Engine.
- (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 :

AENG-B-III

- (a) Introduction.
- (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 :

AENG-B-IV

- (a) Introduction.
- (b) Requirements of a Compressor.
- (c) Centrifugal Compressor :
 - (i) Introduction.
 - (ii) Principles of Operation.
 - (iii) Impellers.
 - (iv) 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) Antistall 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 :

Operating principles and general characteristics.

AENG-B-X

11. V/Stol Engines :

AENG-B-XI

(a) Powerplant 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) Vapour 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.

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) Contact or visual.
 - (ii) Radio.
 - (iii) Radar.
 - (iv) Astro.
 - (v) Dead. Reckoning.
 - (vi) Inertial Navigation.
- (c) The dimensions of Navigation.

2. The form of the 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 Position :**
- (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 ∇ .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) *Azinuthal Projection* :
 - (i) Polar Gnomonic.
 - (ii) Equatorial Gnomonic.
 - (iii) Oblique Gnomonic.
 - (e) *Cylindrical Projections* :
Mercator's Projection.
 - (f) *Topographical Projections* :
 - (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 :

- (a) Revision of basic theory of magnetism.
- (b) The earth's magnetic field.
- (c) The resolution of the earth's magnetic field into components.
- (d) The effect of components of a magnet.
- (e) Aircraft magnetism.
- (f) The resolution of components of aircraft magnetism.
- (g) The derivation of co-efficients.
- (h) The compass swing.

11. Compass No. 1

- (a) *The B-16 Compass :*
- (i) Construction.
 - (ii) Errors and limitations.
 - (iii) Pre-flight check.
- (b) *The J-2 Compass :*
- (i) Construction.
 - (ii) Pre-flight checks.
 - (iii) Errors and limitations.
 - (iv) R.M.I.

12. Computer :

- (a) The need and purpose of the computer.

(b) Solution of :

- (i) Multiplication and division problems on the computer.
- (ii) Time distance and speed problems.
- (iii) Fuel consumption problems.
- (iv) True Air Speed problems.
- (v) The Attitude problems.

(c) Conversion of :

- (i) Units on the computer.
- (ii) Speed to Mach No. and vice. versa.

(d) Computing of heading, drift and ground speed, composite problems.**13. Last Procedure :**

- (a) Causes of error in Navigation.
- (b) The procedure of fuel saving to be adopted when uncertain of position.
- (c) To make use of radio aids if uncertain of position.
- (d) General lost procedure.

14. Pilot Navigation :

- (a) Use of the 'One in Sixty Rule'.
- (b) Solving the problems of 'One in Sixty Rule' on the Computer.
- (c) Gain or lose time by :
 - (i) The 'dog leg'.
 - (ii) By change of I.A.S.
 - (iii) By 'S' turns and 3600 turns.
- (d) Use of position lines for Navigation.
- (e) Use of radio and radar fixes for Navigation.

15. Flight Documents :

- (a) The flight information publication A.F.M. 96-5 and its use in flight planning.
- (b) The high and low level led down charts.

16. Radio Navigation Aids :

- (a) The assistance provided by U.D.F. station.
- (b) The use of fixer stations and typed of fixes.
- (c) Navigation assistance provided by G.C.I. units.
- (d) Radio Compass
- (e) V.O.R.
- (f) Tacan.
- (g) G.C.A.
- (h) I.L.S.

17. Radio Navigation :

- (a) How homing is carried out with the help of Radio Compass.
- (b) How tracking out is carried out with the help of Radio Compass.
- (c) 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 recognising 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 Tracker.