

NTK/KW/15/7462

**Faculty of Engineering & Technology
Fifth Semester B.E. (Aeronautical Engg.) (C.B.S.)
Examination
PROPULSION—I**

Time : Three Hours]

[Maximum Marks : 80

INSTRUCTIONS TO CANDIDATES

- (1) All questions carry marks as indicated.
- (2) Solve **SIX** questions as follows :
Que. No. 1 **OR** Que. No. 2
Que. No. 3 **OR** Que. No. 4
Que. No. 5 **OR** Que. No. 6
Que. No. 7 **OR** Que. No. 8
Que. No. 9 **OR** Que. No. 10
Que. No. 11 **OR** Que. No. 12
- (3) Due credit will be given to neatness and adequate dimensions.
- (4) Assume suitable data wherever necessary.
- (5) Diagrams and chemical equations should be given wherever necessary.
- (6) Illustrate your answers wherever necessary with the help of neat sketches.
- (7) Use of non-programmable calculator is permitted.

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(Contd.)

1. (a) Draw the block diagram and P-V and T-S plot for 3 stage intercooler, 2-stage expansion with regeneration cycle. 6
- (b) With the aid of the schematic diagram and thermodynamic cycle, explain the working of a turboprop engine. 8

OR

2. A closed-cycle gas turbine is to be used in conjunction with a gas nuclear reactor. The working fluid is helium [$C_p = 5.19 \text{ kJ/kg K}$ and $\gamma = 1.66$]. The layout of the plant consists of two-stage compression with inert cooling followed by a heat-exchanger; after leaving the cold side of the heat-exchanger the helium passes through the reactor channels and on to the turbine; from the turbine it passes through the hot-side of the heat exchanger and then a pre-cooler before returning to the compressor inlet. The following data are applicable :

$\eta_c = 0.88$, $\eta_t = 0.88$; Temp at LP compressor inlet = 310 K, Pressure at LP compressor inlet = 14 bar, compressor pressure ratio = 2, Temp at HP compressor inlet = 300 K, mass flow of helium = 180 kg/s, reactor thermal output (heat input to gas turbine) = 500 MW, Pressure loss in pre-cooler and intercooler (each)

process being adiabatic. The compressor has symmetrical blades. The axial velocity of 110 m/s is uniform across the stage and the mean blade speed of each stage is 180 m/s. Determine the direction of the air at entry to and exit from the rotor and stator blades and also the power given to the air. 14

11. (a) What do you understand by the term 'matching of components' ? 6
- (b) Does inlet temperature influence the component match ? Explain. 7

OR

12. (a) Air at a temperature of 17°C flow into the centrifugal compressor running at 20000 rpm. Use the following given data :
slip factor = 0.80, work input factor = 70%, outer diameter of the blade tip = 50 cm.
Assuming the absolute velocities of air entering and leaving the compressor are same, find :
(i) The temperature rise of air passing through compressor.
(ii) The static pressure rise. 8
- (b) Mention the various assumptions in the general matching trends. 5

= 0.34 bar, pressure loss in heat-exchanger (each side)
= 0.27 bar, Pressure loss in reactor channels
= 1.03 bar, helium temp at entry to reactor channels
= 700 K. Calculate the power output and thermal efficiency, and the heat exchanger effectiveness implied by the data. 14

3. (a) What are the non-rotating parts of a turbojet engine ? Briefly explain inlets. 6
(b) Explain boundary layer development under adverse pressure gradient. 7

OR

4. (a) Write all the characteristics on which performance of an inlet depends. 6
(b) What is the purpose of a diffuser in the inlet ? Explain. 7
5. (a) Write the advantages and disadvantages of each type of combustion chamber. 6
(b) Write short notes on flame tube cooling and fuel injection. 7

OR

6. (a) Explain the various forms of combustion system. 6

(b) Explain the process of combustion in gas turbine combustion chamber. 7

7. (a) Derive the expression of Area-ratio of isentropic nozzle. 8
(b) Briefly explain nozzle choking. 5

OR

8. (a) The effective jet velocity from a nozzle of a jet engine is 2700 m/s. The forward flight velocity is 1350 m/s and the air flow rate is 78.6 kg/s. Calculate :
(i) thrust
(ii) thrust power
(iii) propulsive efficiency. 6
(b) With the aid of the diagram, explain the working of convergent nozzle. 7
9. (a) What is a centrifugal compressor and what are its advantages ? 7
(b) With a neat sketch explain the essential parts of a centrifugal compressor. 7

OR

10. Air at a temp. of 290 K enters a ten stage axial flow compressor at the rate of 3 kg/s. The pressure ratio is 6.5 and the isentropic efficiency is 90%, the compression