

# Fifth Semester B.E. Degree Examination, June/July 2024 Aircraft Propulsion

Time: 3 hrs.

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Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

## Module-1

- a. Give general classification of powerplants used in an aircraft. (06 Marks)b. Illustrate the principles of aircraft propulsion. (04 Marks)
  - c. Draw a schematic diagram of a gas turbine engine. Explain its components and their functions.
     (10 Marks)

## OR

- 2 a. With the help of a schematic diagram, write the working of a four stroke petrol engine. Draw the P-V and T-S diagram. (12 Marks)
  - b. Write the advantages of gas turbine engine over reciprocating engine. (08 Marks)

#### Module-2

- 3 a. With a neat sketch, explain blade element theory and criteria for blade selection. (10 Marks)
  b. Write short notes on the following :
  - (i) Variable pitch propeller.
  - (ii) Momentum theory of propeller.

#### OR

- 4 a. With the help of a schematic diagram, explain the working principle and performance characteristics of a Turbojet engine. (10 Marks)
  - b. The absolute jet exit velocity from a jet engine is 2800 m/s and the forward flight velocity is 1400 m/s. Calculate the propulsive efficiency. (04 Marks)
  - c. List the different methods of thrust augmentation, with the help of a relevant sketch explain an afterburner. (06 Marks)

# Module-3

- a. Write the purpose of inlet in gas turbine engine. Explain the operation of subsonic inlets under various operating conditions. (08 Marks)
  - b. Explain with neat sketches shock swallowing supersonic inlets. (04 Marks)
  - c. Air ( $\gamma = 1.4$ , R = 287.43 J/kg K) enters a straight axis symmetric duct at 300 K, 3.45 bar and 150 m/s and leaves it at 277 K, 2.058 bar and 260 m/s. The area of cross section at entry is 500 cm<sup>2</sup>. Assuming adiabatic flow determine (i) Maximum velocity (ii) Mass flow rate. (08 Marks)

### OR

6 a. Explain flow conditions in a convergent-divergent (C-D) nozzle for varying back pressure conditions. Show pressure variation and formation of shock with the help of sketches.

(10 Marks)

(10 Marks)

(10 Marks)

- b. Write short notes on:
  - (i) Over expanded and Under damped nozzle.
  - (ii) Ejector and variable area nozzle.
  - (iii) Thrust reversal.

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Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. 2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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(10 Marks)

# Module-4

- 7 a. Draw a neat diagram and explain the working of a centrifugal compressor for a gas turbine engine. What are its advantages and disadvantages. (10 Marks)
  - b. A centrifugal compressor under test gave the following data : Speed : 11,500 rev/min Inlet total head temperature : 21°C Outlet and inlet total head pressure : 4 bar, 1 bar Impeller dia : 75 cm If the slip factor is 0.92, what is the compressor efficiency?

#### OR

- 8 a. Define Degree of reaction and derive an expression for the same with usual notations for an axial flow compressor. (08 Marks)
  - b. Enumerate the process of surging and stalling in an axial flow compressor. (04 Marks)
  - c. Determine the stage efficiency,  $\eta_s$  and work done factor  $\Omega$  of an axial flow compressor, if the actual pressure ratio developed was 1.35 and actual temperature rise was 30 K. The blade inlet and outlet angles are 47° and 15° respectively. The peripheral and axial velocities are 225 m/s and 180 m/s respectively. (08 Marks)

#### Module-5

- 9 a. Describe the process of combustion in a gas turbine engine. With neat sketch, explain (10 Marks)
  - b. With the help of relevant sketches, explain flame tube cooling and flame stabilization.

(10 Marks)

## OR

- 10 a. Draw the variation of pressure and velocity in a Reaction Turbine and explain the operating (08 Marks)
  - b. Describe the different methods of turbine blade cooling with relevant sketches. Also explain the effect of cooling air on turbine performance. (12 Marks)

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