Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
Aircraft Propulsion

Time: 3 hrs.   Max. Marks: 100

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

Module-1

1   a. Illustrate the principles of aircraft propulsion. Give the general classification of power plants. **(08 Marks)**

   b. With the help of a schematic diagram, describe the working of a four-stroke petrol engine. Draw the P-V and T-S diagram and list its advantages and disadvantages. **(12 Marks)**

OR

2   a. List the advantages of gas turbine engines over reciprocating engines. **(08 Marks)**

   b. Draw the schematic diagram of a simple gas turbine engine along with the P-V and T-S diagram and derive an expression for net work output and efficiency with usual notations. **(12 Marks)**

Module-2

3   a. List the different types of propeller. With the help of a propeller nomenclature diagram, explain the different types of propeller. **(08 Marks)**

   b. Describe blade element theory with relevant sketches. **(06 Marks)**

   c. Define thrust. Derive the general form of thrust equation with usual notations. **(06 Marks)**

OR

4   a. With the help of a neat schematic diagram, illustrate the working of a Turbojet engines. Draw its performance characteristic curves and list its advantages and disadvantages. **(08 Marks)**

   b. Explain the method of thrust augmentation using an afterburner with relevant sketches. **(06 Marks)**

   c. An aircraft flies at 960 kmph. One of its turbojet engines takes in 40 kg/s of air and expand the gases to the ambient pressure. The air fuel ratio is 50 and the lower calorific value of the fuel is 43 mJ/kg. For maximum thrust power, determine: (i) Jet velocity (ii) Thrust (iii) Thrust power (iv) Propulsive, overall and thermal efficiencies. **(06 Marks)**

Module-3

5   a. List the characteristics on which the performance of an inlet depend and explain the subsonic inlets with the help of typical stream line pattern. **(10 Marks)**

   b. Air ($\gamma = 1.4$, R = 287.43 K/kg°K) enters a straight axisymmetric 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^2. Assuming adiabatic flow, determine: (i) Stagnation temperature (ii) Maximum velocity (iii) Mass flow rate (iv) Area of cross section at exit. **(10 Marks)**

OR

6   a. With the help of relevant sketches, describe the following:
   (i)   Thrust reversing and vectoring
   (ii) Over expanded nozzle. **(10 Marks)**

b. Air flowing in a duct has a velocity of 300 m/s, pressure 1.0 bar and temperature 290 K. Taking $\gamma = 1.4$ and R = 287 J/kgK, determine:
   (i)   Stagnation pressure and temperature
   (ii) Velocity of sound in the dynamic and stagnation conditions
   (iii) Stagnation pressure assuming constant density.   (10 Marks)

Module-4

7 a. List the advantages of centrifugal compression and describe the essential parts of a centrifugal compressor with a neat schematic diagram and explain the principle of operation.
                                                                           (10 Marks)
   b. A centrifugal compressor under test gave the following data: speed = 11,500 rpm, 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?   (06 Marks)
   c. Explain Vaneless diffusers fitted in centrifugal compression.   (04 Marks)

OR

8 a. Describe the basic principle of operation of a axial flow compressor with relevant sketches. List the main characteristics of axial flow compressor.   (10 Marks)
   b. A 10 stage axial flow compressor provides an overall pressure ratio of 5:1 with an overall isentropic efficiency of 51%, when the temperature of air at inlet is 15°C. The work is equally divided between the stages. A 50% reaction is used with a blade speed of 210 m/s and a constant axial velocity of 170 m/s. Estimate the blade angles. Assume a work done factor of 1.   (06 Marks)
   c. Brief the advantages of axial flow compressor over centrifugal flow compressor.   (04 Marks)

Module-5

9 a. List the steps involved in the process of combustion in a gas turbine combustor. Explain with relevant sketches.   (08 Marks)
   b. Describe the different types of combustions band on geometry.   (06 Marks)
   c. With the help of relevant sketches, explain flame tube cooling.   (06 Marks)

OR

10 a. With the help of a neat schematic diagram showing a stage of a turbine with pressure and velocity variations, explain a reaction turbine.   (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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