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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February / March 2023 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 20AE5DCBPR **Max Marks: 100**
Course: Basic Propulsion **Date: 21.02.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Explain the working principle of ramjet engine with a neat diagram and draw the thermodynamic cycle of the ramjet engine and write the equation of thrust for the ramjet. **12**

b) An aeroplane equipped with turbo jet engine flying at 1350 km/h. the SFC of the eninge is 0.2 kg/hr/ N of thrust. The thrust developed by the engine is 10kN. The air flow through the compressor is 40kg/s. find out the A:F ratio supply to the engine and overall efficiency of the system. Take C.V= 42.5 MJ/kg **8**

OR

2 a) Explain the Single spool Turbojet engine with an aid of neat diagram along with thermodynamic and Ideal analysis case. **10**

b) An advanced fighter engine operating at Mach 0.8 and 10-km altitude has the following uninstalled performance data and uses a fuel with Q_{pg} = 42,800 kJ/kg: F=50kN, m_o=45kg/s and m_f=2.65kg/s. Determine the specific thrust, thrust specific fuel consumption, exit velocity, thermal efficiency, propulsive efficiency, and overall efficiency (assume exit pressure equal to ambient pressure). **10**

UNIT - II

3 a) Explain sub critical, critical and supercritical mode of operations of supersonics intake. Use necessary sketches. **10**

b) Explain the different types of combustors with a neat sketch. What are the requirements of a combustors? **10**

UNIT - III

4 a) Air at 1.0 bar and 288 K enters an axial flow compressor with an axial velocity of 150 m/s. There are no inlet guide vanes. The rotor stage has a tip diameter of 60 cm and a hub diameter of 50 cm and rotates at 100 rps. The air enters the rotor and leaves the stator in the axial direction with no change in velocity or radius. The air is turned through 30.2^o as it passes through the rotor. Assume an overall pressure ratio of 6 and a stage pressure ratio of 1.2. Find **10**

i. the mass flow rate of air
ii. the power required to drive the compressor,
iii. the degree of reaction at the mean diameter,

b) What are the various stage influencing parameters in Axial flow compressors? Explain them with suitable sketches. **10**

UNIT - IV

5 a) A single-stage axial-flow turbine has a mean radius of 30 cm and a blade height at the stator inlet of 6 cm. The hot gases enter the turbine stage at 1900 kPa and 1200 K, and the absolute velocity leaving the stator (C2) is 600 m/s and inclined at an angle of 65° to the axial direction. The relative angles at the inlet and outlet of the rotor blade are 25° and 60°, respectively. The stage efficiency is 0.88. Calculate **10**

i. The absolute angle $\alpha 3$
ii. The rotor rotational speed in rpm
iii. The stage pressure ratio
iv. The flow coefficient, blade loading coefficient and degree of reaction
v. The mass flow rate
vi. The power delivered by the turbine Take $\gamma=1.33$, R = 290 J/kg K, and Ca/U as constant through the stage

b) With the help of T - S pot explain the working principle of axial turbine. **10**

OR

6 a) What are the various losses in Turbines. **6**

b) A multi-stage axial turbine is to be designed with impulse stages and is to operate with an inlet pressure and temperature of 6 bar and 900 K and outlet pressure of 1 bar. The isentropic efficiency of the turbine is 85 %. All the stages are to have a nozzle outlet angle of 75o and equal inlet and outlet rotor blade angles. Mean blade speed is 250 m/s and the axial velocity is 150 m/s and is a constant across the turbine. Estimate the number for stages required for this turbine **10**

c) Compare Compressors and Turbines. **4**

UNIT - V

7 a) Explain the working principle of centrifugal compressor and give the details of the performance characteristics. Use necessary sketches for both. **10**

b) Air is compressed in a centrifugal compressor having the following properties: **10**
Rotational speed is 5400 rpm
Mass flow rate is 20 kg/s
Air density at impeller inlet is 1.115 kg/m^3
Air density at impeller outlet is 1.45 kg/m^3
Impeller inlet radius is 0.3 m
Impeller outlet radius is 0.56 m
Power consumed in driving the impeller is 750 kW, and entry is radial with a component of 60 m/s which is constant throughout. Calculate

i. The width at inlet and outlet
ii. Temperature rises in compressor
iii. 3. Angles: $\alpha 1$, $\alpha 2$, $\beta 1$, $\beta 2$

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