MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
*(A constituent institution of MAHE, Manipal)*

**IV SEMESTER B. TECH (AERONAUTICAL ENGINEERING)**
**END-SEMESTER EXAMINATION, JUNE, 2021**
**COURSE: AIRCRAFT PROPULSION (AAE 2255)**

**REVISED CREDIT SYSTEM**

**Duration: 3 Hours** **Date: 14/06/2022** **MAX. MARKS: 50**

***Note:***

- *All questions are compulsory*
- *Draw a neat diagram wherever necessary*
- *Stepwise answers carry marks*
- *Assume suitable data if necessary*

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| **Q1.** | Write the classification of gas turbine engines | **[2M]** |
| **Q2.** | Describe the working principle of a valveless pulsejet engine, as well as its advantages and disadvantages. | **[4M]** |
| **Q3.** | Draw a ramjet engine's real cycle diagram and explain the different processes. Also, for the ramjet engine, derive an expression for the fuel-air ratio. | **[4M]** |
| **Q4.** | Write the applications of turboshaft engine and explain how the turboshaft engine is different than the turboprop engine. | **[2M]** |
| **Q5.** | Define the following terms.<br>i. perfect gas<br>ii. thermally perfect gas<br>iii. calorically perfect gas | **[3M]** |
| **Q6.** | A turbofan engine flies with Mach 0.7 at an altitude where the ambient pressure and temperatures are 28.5 kPa and 227.3 K, respectively. The air enters the engine at a rate of 110 kg/s and fuel is supplied at a rate of 0.55 kg/s. The engine bypass ratio is 6 and the fuel heating value is 43 MJ/kg. If the cold and hot stream exit velocities are 1.5 and 2 times the flight speed, determine (a) the total thrust generated (b) TSFC (c) propulsive efficiency using second expression and (d) thermal efficiency. | **[5M]** |
| **Q7.** | Draw the actual Brayton cycle for turbojet engine with afterburner and name different processes. | **[2M]** |
| **Q8.** | Derive an expression for the area-velocity relation for a nozzle. | **[3M]** |
| **Q9.** | Air enters the compressor of a gas turbine engine at 300 K and 0.1 MPa. The compression and expansion ratios are 2.5. The maximum cycle temperature is 1300 K. The isentropic efficiencies of compressor and turbine are 0.85 and 0.88, respectively. The engine is equipped with a 70% effective regenerator. Draw the cycle diagram and determine the (a) net work transfer (b) back wok ratio and (c) percent improvement in thermal efficiency due to the regenerator. | **[5M]** |

**Q10.** Describe the significance of bypass ratio in a turbofan engine. **[2M]**

**Q11.** Draw the propulsive efficiency vs. airspeed plot for different engines and explain which engine is more efficient at low speed applications and why? **[3M]**

**Q12.** An aircraft flying with a speed of 350 m/s is powered by a turbojet engine which produces 15 kN thrust at an ambient pressure of 28 kPa and ambient temperature of 225 K. The compressor pressure ratio is 10 and gases leaves the combustion chamber at 1300 K. Assuming ideal cycle operation and back work ratio of 0.95, determine the (a) fuel-air ratio (b) exhaust gas velocity and (c) propulsive efficiency using second expression. Assume the unchoked nozzle and constant specific heats. The fuel heating value is 42,500 kJ/kg. **[5M]**

**Q13.** Write a note on degree of reaction in axial flow compressors. **[2M]**

**Q14.** Draw the enthalpy-entropy and pressure-volume diagrams for the ideal Brayton cycle and explain different processes. **[3M]**

**Q15.** An axial flow compressor has a mean diameter of 50 cm and runs at 12000 rpm. The actual temperature rise and pressure ratio developed are 30 deg. C and 1.2, respectively. Determine the power required to drive the compressor for a mass flow rate of 40 kg/s and mechanical efficiency of 82%. The initial temperature of air is 25 deg. C. Also determine the stage loading coefficient, stage efficiency and degree of reaction if the temperature at the rotor exit is 50 deg. C. **[5M]**