



**B.E DEGREE EXAMINATIONS: NOV/DEC 2023**

(Regulation 2018)

Fifth Semester

**AERONAUTICAL ENGINEERING**

U18AEI5205: Aircraft Propulsion

**COURSE OUTCOMES**

**CO1:** Analyze overall performance of an aircraft engines.

**CO2:** Explain the relation between area ratio and external deceleration ratio for diffuser.

**CO3:** Describe the combustion mechanisms of gas turbine engine.

**CO4:** Calculate the operating characteristics of compressors, turbines and nozzles.

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 2 = 20 Marks)**

**(Answer not more than 40 words)**

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|---|-----|-------------------|
| 1. A turbo fan engine has a bypass ratio of 8 and total mass flow rate of 180 kg/s. Determine the mass flow through the bypass duct.  | CO1 | [K <sub>2</sub> ] |
| 2. Air enters the combustor of gas turbine engine at total temperature of 500K and leaves the combustor at 1800K. If Cp remains constant at 1.005kJ/kgK and having calorific value of 44MJ/kg,determine the fuel air ratio. | CO1 | [K <sub>2</sub> ] |
| 3. List down the functions of inlets .  | CO2 | [K <sub>1</sub> ] |
| 4. State the application of S-Duct and Bellmouth Inlet.   | CO2 | [K <sub>1</sub> ] |
| 5. State the purpose of swirl vanes in combustion chamber.  | CO3 | [K <sub>2</sub> ] |
| 6. Define stoichiometric and equivalence ratio.   | CO3 | [K <sub>2</sub> ] |
| 7. Define flow coefficient and stage loading coefficient.   | CO4 | [K <sub>1</sub> ] |
| 8. Classify the compressor stage based on degree of reaction.   | CO4 | [K <sub>2</sub> ] |
| 9. What is meant by De Laval nozzle?  | CO4 | [K <sub>1</sub> ] |
| 10. How the fluid gets accelerated in divergent section of CD Nozzle.   | CO4 | [K <sub>2</sub> ] |

**Answer any FIVE Questions:-**

**PART B (5 x 16 = 80 Marks)**

**(Answer not more than 400 words)**

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|--|----|-----|-------------------|
| 11. The airplane Fiat G91Y is a single-seat Strike and Reconnaissance fighter powered by two General Electric J85-GT-13A turbojets each rated at 12.12 kN at | 16 | CO1 | [K <sub>4</sub> ] |
|--|----|-----|-------------------|

an altitude of 9150 m where the ambient conditions are 32 kPa and 240 K. The pressure ratio across the compressor is 12 and temperature at the turbine inlet is 1400 K. The aircraft speed is 310 m/s. Assume ideal operation for all components, assume nozzle is fully expanded and constant specific heat in all processes,  $C_p = 1.005 \text{ kJ/kg K}$ . The heating value of the fuel is 42,700 kJ/kg.

Determine,

1. Fuel-to-air ratio
2. The velocity of the exhaust gases
3. The air mass flow rate
4. The propulsive efficiency
5. The thermal efficiency
6. The overall efficiency

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|-----|----|--|----|-----|-------------------|
| 12. | a) | With neat sketch, briefly explain about starting problem in supersonic inlets.   | 10 | CO2 | [K <sub>3</sub> ] |
|     | b) | What are various requirements of aircraft intake?  | 6  | CO2 | [K <sub>2</sub> ] |
| 13. | a) | Briefly discuss about various types of combustion chamber design and its merits and demerits.  | 8  | CO3 | [K <sub>2</sub> ] |
|     | b) | With neat sketch, explain the working principle of combustion chamber.   | 8  | CO3 | [K <sub>3</sub> ] |
| 14. | a) | With neat sketch, explain the working principle of axial and radial flow compressors.  | 6  | CO4 | [K <sub>3</sub> ] |
|     | b) | A 10-stage axial flow compressor provides an overall pressure ratio of 5:1 with an overall isentropic efficiency of 87%. When the temperature of air at inlet is 15°C. The work is equally divided between stages. 50% reaction is used with blade speed of 210 m/s and constant axial velocity of 170 m/s. Estimate the blade angles. Assume a work done factor of 1. | 10 | CO4 | [K <sub>4</sub> ] |
| 15. | a) | With neat sketch, briefly discuss about the various methods involved in turbine blade cooling.   | 8  | CO4 | [K <sub>3</sub> ] |
|     | b) | With neat sketch, explain various thrust vector mechanism used in aircrafts.   | 8  | CO4 | [K <sub>2</sub> ] |
| 16. | a) | Define thrust and derive the thrust equation for turbojet engine in various forms.   | 10 | CO1 | [K <sub>3</sub> ] |
|     | b) | With neat sketch, explain the working principle of afterburner technique.  | 6  | CO1 | [K <sub>2</sub> ] |

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