

# CRASH COURSE

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10AE55

## Fifth Semester B.E. Degree Examination, May 2017 Aircraft Propulsion

Time: 3 hrs.

Max. Marks: 100

- Note:** 1. Answer any FIVE full questions, selecting at least TWO questions from each part.  
2. Use of compressible flow isentropic table is permitted.

### PART – A

- 1 a. State : (i) Fourier's law of heat conduction (ii) The Stefan – Boltzmann law of radiation. (04 Marks)
- b. A surface having an area of  $1.5 \text{ m}^2$  and maintained at  $300^\circ\text{C}$  exchanges heat by radiation with another surface at  $40^\circ\text{C}$ . The value of factor due to the geometric location and emissivity is 0.52. Determine (i) Heat lost by radiation (ii) The value of thermal resistance (iii) The value of equivalent convection coefficient. Assume  $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \text{ K}^4$ . (06 Marks)
- c. Air is discharged from a reservoir at  $P_0 = 6.91 \text{ bar}$  and  $T_0 = 325^\circ\text{C}$  through a nozzle to an exit pressure of 0.98 bar. If the flow rate is 3600 kg/hr, determine for isentropic flow  
(i) Throat area, pressure and velocity  
(ii) Exit Mach number  
(iii) Maximum velocity. (10 Marks)
- 2 a. Air enters a turbojet engine at a rate of  $12 \times 10^4 \text{ kg/h}$  at  $15^\circ\text{C}$  and 1.03 bar and is compressed adiabatically to  $182^\circ\text{C}$  and four times the pressure products of combustion enters the turbine at  $815^\circ\text{C}$  and leave it  $650^\circ\text{C}$  to enter the nozzle. Calculate the isentropic efficiency of compressor, power required to drive compressor, the exit speed of gases and thrust developed when flying 800 km/h. Assume isentropic efficiency of turbine is same as that of compressor and nozzle efficiency is 90%. (10 Marks)
- b. Explain working principle of turboprop engine and write advantages and disadvantages. (10 Marks)
- 3 a. Derive a relation for minimum area ratio in terms of external deceleration and max coefficient of pressure. (10 Marks)
- b. Explain shock swallowing by overspeeding method with neat sketch. (10 Marks)
- 4 a. Write short notes on :  
(i) Flame tube cooling (05 Marks)  
(ii) Combustion stability curve. (05 Marks)
- b. Explain with graph, isentropic flow through C-D nozzle. (10 Marks)

Important Note - 1 On completing your answers, compulsorily draw diagonal cross lines on the remaining blank space. Any scribble or re-communication appear to evaluator and/or equations written e.g.  $4 \times 8 = 30$ , will be treated as inappropriate.

**PART – B**

- 5 a. List and explain performance parameters of centrifugal flow compressor with neat sketch. (10 Marks)
- b. Air at 1.0132 bar and 288 K enters an axial flow compressor stage with an axial velocity 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. The air is turned through  $30.2^\circ$  as it passes through rotor. Assume a stage pressure ratio of 1.2. Assuming the constant specific heats and that the air enters and leaves the blade at the blade angles.
- (i) Construct the velocity diagram at mean dia of this stage.
- (ii) Mass flow rate
- (iii) Power required. (10 Marks)
- 6 a. Draw velocity triangles of single stage turbine and derive the expression for work output (10 Marks)
- b. Write short notes on a reaction turbine. (05 Marks)
- c. Define blade loading and flow coefficient and show relation between them. (05 Marks)
- 7 a. Derive thrust equation for ramjet engine. (07 Marks)
- b. Explain performance of ramjet engine. (07 Marks)
- c. Explain working principle of supersonic combustion ramjet engine with neat sketch. (06 Marks)
- 8 a. With a neat sketch, explain the working principle of liquid propellant rocket. Also write advantages and disadvantages. (10 Marks)
- b. Define internal efficiency and propulsive efficiency of a rocket. (04 Marks)
- c. Define specific impulse of a rocket. Derive expression for it. (06 Marks)

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