

--	--	--	--	--	--	--	--	--	--

Fifth Semester B.E. Degree Examination, Dec.2013/Jan.2014
Aircraft Propulsion

Time: 3 hrs.

Max. Marks: 100

**Note: Answer FIVE full questions, selecting
at least TWO questions from each part.**

PART – A

1.
 - a. Explain the principles of aircraft propulsion and list down the general classifications power plants used in flight vehicles. (05 Marks)
 - b. Define the terms thermal conduction convection and radiation and derive the Fourier law of heat conduction equation. (10 Marks)
 - c. A wall of 0.6m thickness having thermal conductivity of 1.2W/m°K. The wall is to be insulated with a material having an average thermal conductivity of 0.3W/m°K. Inner and outer surfaces temperatures are 1000°C and 10°C. Heat transfer rate is 1400W/m². Calculate the thickness of insulation. (05 Marks)

2.
 - a. Derive the general thrust equation of a gas turbine engine and also write down thrust equations for a turboprop and turbofan engines. (06 Marks)
 - b. Draw a schematic diagram of a turboprop engine, explain its working principle and indicate its advantages and disadvantages. (07 Marks)
 - c. A turboprop engine operates at an altitude of 3000m above mean sea level and an aircraft speed of 525 kmph. The data for engine is given below:
 Diffuser efficiency = 0.875
 Isentropic efficiency of compressor = 0.79
 Velocity of air at the compressor = 90m/sec
 Temperature rise through the compressor = 230°C
 Temperature, pressure and density at 3000m altitude are 268.65°K, 0.701 bar and 909 kg/m³ respectively. Properties of air: $\gamma = 1.4$, $C_p = 1.005$ kJ/kg·K. Calculate the pressure rise through the diffuser, pressure ratio developed by the compressor, power required by the compressor and the air standard efficiency. (07 Marks)

3.
 - a. Explain on any two of the following with relevant sketches:
 - i) Supersonic inlets.
 - ii) Factors affecting diffuses performance.
 - iii) Shock swallowing. (10 Marks)
 - b. Derive a relation for minimum area ratio $\left(\frac{A_{max}}{A_1}\right)_{min}$ in terms of external decleration $\frac{u_1}{u_2}$ and also explain with relevant graphs. (10 Marks)

4.
 - a. What are the classifications of combustion chamber, explain with neat sketches. Discuss their advantages and disadvantages. (06 Marks)
 - b. Explain on any two of the following:
 - i) Flame tube cooling.
 - ii) Use of cheaper fuels.
 - iii) Pollution. (06 Marks)
 - c. What are the functions of exhaust nozzle and explain over expanded and under expanded nozzle. (08 Marks)

PART – B

- 5 a. Draw a schematic diagram of a centrifugal compressor and obtain an expression for work done and pressure rise. (08 Marks)
- b. Define degree of reaction for an axial flow compressor and obtain the expression for 50% degree of reaction. (06 Marks)
- c. 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 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 = 1. (06 Marks)
- 6 a. Draw the velocity triangles of a single stage turbine and derive the expression for work output. (10 Marks)
- b. A multistage gas turbine is to be designed with impulse stages and is to operate with an inlet pressure and temperature of 6 bar and 900K and an outlet pressure of 1 bar. The isentropic efficiency of the turbine is 85%. All the stages are to have a nozzle outlet angle of 75° and equal outlet and inlet blade angles. Mean blade speed of 250m/s and equal inlet and outlet gas velocities. Estimate the maximum number of stages required. Assume $C_p = 1.15$ kJ/kg K, $\gamma = 1.333$ and optimum blade speed ratio. (10 Marks)
- 7 a. Draw a schematic diagram of a SCRAMJET engine. Explain its performance characteristics and indicate its advantages and disadvantages. (10 Marks)
- b. Explain the subcritical, critical and supercritical operation of combustion in ramjet engine. (10 Marks)
- 8 a. Draw a schematic diagram of a liquid propellant rocket. Explain its principle of operation and discuss its advantages and disadvantages. (10 Marks)
- b. Describe the concept of multistaging of rockets and indicate different types of multistaging with neat sketches and derive a relation for terminal velocity of multi stage rocket. (10 Marks)

* * * * *