

**B.E. DEGREE EXAMINATIONS: APRIL / MAY 2010**

Third Semester

**AERONAUTICAL ENGINEERING**

U07AR301: Aero Engineering Thermodynamics

**Time: Three Hours****Maximum Marks: 100**

Use of Steam Tables may be permitted

**Answer ALL the Questions:-****PART A (10 x 1 = 10 Marks)**

1. During a cycle comprising four processes, the heat transfers are the following: 60 KJ, - 8KJ, -24KJ, & 6KJ. The cycle work is
  - a. 3627 Nm
  - b. 34 KJ
  - c. 98 KJ
  - d. 10450 Nm
2. Which of the following properties are intensive properties:
  - a. Volume
  - b. temperature
  - c. pressure
  - d. density
3. In petrol engine the air – fuel mixture is ignited by
  - a. high temperature rise due to heat of compression
  - b. high temperature rise due to spark struck by spark plug.
  - c. high temperature glow bulb
  - d. high temperature rise due to combustion
4. The gas turbine cycle with regenerator improves
  - a. Thermal efficiency
  - b. Work ratio
  - c. Avoids pollution
  - d. Net work transfer
5. The enthalpy of evaporation of steam with increase of pressure
  - a. Increases
  - b. Decreases
  - c. Remains same
  - d. Independent of pressure
6. Which of the following is not a component of a gas turbine engine
  - a. After burner
  - b. Combustion chamber
  - c. Condenser
  - d. Compressor
7. In vapour compression refrigeration system the heat is absorbed from the environments to be cooled by
  - a. Evaporator
  - b. Condenser
  - c. Compressor
  - d. Throttle valve
8. The ambient air temperature as recorded by ordinary thermometer is called
  - a. Wet bulb temperature
  - b. Dew point temperature
  - c. Dry bulb temperature
  - d. Saturation temperature
9. The purpose of providing clearance volume in reciprocating air compressor is
  - a. To reduce the work done / kg of air

- b. To increase the volumetric efficiency of compressor
  - c. To accommodate valves in the head of the compressor
  - d. To create turbulence in air to the delivered
10. In a centrifugal air compressor the pressure developed depends on
- a. Impeller tip velocity
  - b. Inlet temperature
  - c. Compression index
  - d. All the above

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

- 11. What are intensive and extensive properties? Give at least one example for each one of them.
- 12. State the first law of thermodynamics.
- 13. What are the assumptions made in air – standard cycle analysis?
- 14. Show the Brayton cycle on p – V & T – s diagrams.
- 15. What is dryness fraction?
- 16. Define the terms: Propulsive power and Propulsive efficiency.
- 17. Show that the coefficient of performance of a heat pump is greater than unity.
- 18. What is a tonne of refrigeration?
- 19. Define volumetric efficiency and free air delivery of a compressor.
- 20. What are the advantages of multistage compression with intercooling?

**PART C (5 x 14 = 70 Marks)**

21. (a) 0.5 kg of air is compressed reversibly and adiabatically from 80 kPa, 60°C to 0.4 Mpa, and is then expanded at constant pressure to the original volume. Sketch these processes on the p-V and T-s planes. Compute the heat transfer and work transfer for the whole path.

**(OR)**

- (b) Air at a temperature of 15°C passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 800°C. It then enters a turbine with the same velocity of 30 m/s and expands until the temperature falls to 650°C. On leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 500°C. If the air flow rate is 2 kg/s, calculate (i) the rate of heat transfer to the air in the heat exchanger (ii) the power output from the turbine assuming no heat loss (iii) velocity at the exit from the nozzle assuming no heat loss.

22. (a) An engine working on Otto cycle is supplied with air at 0.1 Mpa, 35°C. The compression ratio is 8. Heat supplied 2100 kJ/kg. Calculate the maximum pressure and temperature of the cycle, the cycle efficiency and the mean effective pressure.

**(OR)**

(b) A gas turbine unit has a pressure ratio of 10 and a maximum cycle temperature of  $700^{\circ}\text{C}$ . The isentropic efficiencies of the compressor and turbine are 0.82 and 0.85 respectively. Calculate the power output of an electric generator geared to the turbine when the air enters the compressor at  $15^{\circ}\text{C}$  at the rate of 15 kg/s. Take  $c_p=1.005$  kJ/kgK and  $\gamma=1.4$  for the compression process, and take  $c_p=1.11$  kJ/kgK and  $\gamma=1.333$  for the expansion process.

23. (a) Steam at 50 bar,  $400^{\circ}\text{C}$  expands in Rankine cycle to 0.34 bar. For 150 kg/s of steam determine (i) the power developed, (ii) the thermal efficiency, and (iii) specific steam consumption.

(OR)

(b) Air at 8.6 bar and  $190^{\circ}\text{C}$  expands at the rate of 4.5 kg/s through a convergent-divergent nozzle into a space at 1.03 bar. Assuming that the inlet velocity is negligible, calculate the throat and the exit cross sectional areas of the nozzle.

24. (a) With the help of a neat sketch, explain the working of a simple vapour compression refrigeration system. Show the cycle on p-h coordinates.

(OR)

(b) With neat diagrams, explain the working of a summer air conditioning system. Show the processes on psychrometric chart.

25. (a) With the help of a neat sketch, explain the construction and working principle of a simple reciprocating compressor. Show the processes on p-V diagram.

(OR)

(b) A single stage double acting air compressor of 62.5 kW power input, running at 120 rpm, takes air at 1 bar and delivers at 10 bar. Assuming the law of expansion and compression as  $pV^{1.35}=\text{constant}$ , find the diameter and stroke of the cylinder. Take piston speed=200 m/min, volumetric efficiency=90%. Also find the clearance volume as a percentage of stroke volume.

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