

Question Paper Code : 64029

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2010

Fourth Semester

Electronics and Instrumentation Engineering

EI 2254 — APPLIED THERMODYNAMICS

(Common to Instrumentation and Control Engineering)

(Regulation 2008)

Time : Three hours

Maximum : 100 Marks

Use of steam tables, refrigeration tables, psychrometric charts and heat and mass transfer tables is permitted.

Answer ALL questions

PART A — (10 × 2 = 20 Marks)

1. Define the first law of thermodynamics. State its limitations.
2. Why is direct heating thermodynamically wasteful?
3. What is an air standard cycle? Why are such cycles conceived?
4. As far as mileage is concerned, four stroke engines are better than the two stroke engines. Justify.
5. How is boiler efficiency calculated?
6. What is meant by governing of steam turbines? Name any two methods of governing of steam turbines.
7. How can the work done during compression process in a reciprocating compressor be minimised practically? Mention any two methods.
8. Define Dew point temperature. Under what condition the DBT, WBT and DPT are equal.
9. Sketch the temperature and velocity profiles in free convection on a vertical wall.
10. Distinguish between a black body and a gray body.

PART B — (5 × 16 = 80 Marks)

11. (a) (i) Prove that heat is a path function. (4)
- (ii) In a gas turbine the gas enters at the rate of 5 kg/s with a velocity of 50 m/s and enthalpy of 900 kJ/kg and leaves the turbine with a velocity of 150 m/s and enthalpy of 400 kJ/kg. The loss of heat from the gases to the surrounding is 25 kJ/kg. Assume for gas $R = 0.285$ kJ/kg K and $C_p = 1.005$ kJ/kg K and the inlet conditions to be at 100 kPa and 27°C. Determine the power output of the turbine and the diameter of the inlet pipe. (12)

Or

- (b) (i) Show that the COP of a heat pump is greater than the COP of a refrigerator by unity. (4)
- (ii) Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 420°C from a hot source, while engine B is in communication with a cold sink at a temperature of 5°C. If the work output of A is twice that of B, find
- (1) The intermediate temperature between A and B,
 - (2) The efficiency of each engine, and
 - (3) The heat rejected to the cold sink. (12)

12. (a) (i) Distinguish between two stroke cycle and four stroke cycle engines. (4)
- (ii) An engine working on Otto cycle has an air standard cycle efficiency of 56% and rejects 545 kJ/kg of air. The pressure and temperature of air at the beginning of compression are 0.1 MPa and 60 °C respectively. Compute
- (1) The compression ratio of the engine,
 - (2) The work done per kg of air,
 - (3) The pressure and temperature at the end of compression, and
 - (4) The maximum pressure in the cycle. (12)

Or

- (b) (i) Compare SI and CI engines. (8)
- (ii) With the help of p-V and T-s diagram, show that for the same maximum pressure and temperature of the cycle and the same heat rejection.

$$\eta_{\text{diesel}} > \eta_{\text{otto}} > \eta_{\text{carnot}} \quad (8)$$

13. (a) (i) Why modern boilers use high pressure and temperatures? (4)

(ii) Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler.

(1) Assuming ideal processes, find per kg of steam the net work and the cycle efficiency.

(2) If the turbine and the pump have each 80% efficiency, find the percentage reduction in the net work and cycle efficiency. (12)

Or

(b) (i) Show that for a Parson's reaction turbine, the degree of reaction is 50%. (4)

(ii) A reaction turbine runs at 300 rpm and its steam consumption is 15500 kg/h. The pressure of steam at certain pair is 1.9 bar; its dryness 0.93 and power developed by the pair is 3.5 kW. The discharging blade tip angle is 20° for both fixed and moving blades and the axial velocity of flow is 0.72 of the blade velocity. Find the drum diameter and blade height. Take the tip leakage steam as 8%, but neglect blade thickness. (12)

14. (a) (i) Explain the working of a centrifugal compressor and obtain an expression for the work done. (4)

(ii) A two stage single acting reciprocating air compressor draws in air at a pressure of 1 bar and 17°C and compresses it to a pressure of 60 bar. After compression in the LP cylinder, the air is cooled at a constant pressure of 8 bar and a temperature of 37°C. The low pressure cylinder has a diameter of 150 mm and both the cylinders have 200 mm stroke. If the law of compression is $pV^{1.35} = C$, find the power of the compressor, where it runs at 200 rpm. Take $R = 0.287$ kJ/kg K. (12)

Or

(b) (i) In a laboratory test, a sling psychrometer recorded dry bulb and wet bulb temperatures as 30°C and 25°C respectively. Calculate

(1) Vapour pressure

(2) Specific humidity. (4)