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Question Paper Code : 31423

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Fourth Semester

Electronics and Instrumentation Engineering

EI 2254/EI 46/ME 1260/10133 EI 406/080300011 — APPLIED THERMODYNAMICS

(Common to Instrumentation and Control Engineering)

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Use of steam tables, refrigeration tables, psychrometric charts and Heat and Mass transfer tables are permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define thermodynamic system with its types.

2. In a cyclic process, heat transfers are +14.7 kJ, –25.2 kJ, –3.56 kJ, +31.5 kJ. What is the net work for this cyclic process?

3. The compression ratio of an Otto cycle is 9. Determine for an initial condition of 1 bar and 313 K, the cycle efficiency.

4. What are applications of four stroke petrol engine?

5. Compare impulse turbine with reaction turbine.

6. Define the term 'stage efficiency' for a reaction turbine.

7. Define one tonne of refrigeration.

8. Classify the air compressors.

9. The wall of a furnace is constructed from 15 cm thick fire brick having thermal conductivity =1.7 W/mK. The two sides of the wall are maintained at 1400 K and 1150 K respectively. What is the rate of heat loss through the wall which is 50 cm × 3 m on a side?

10. Calculate the emissive power for an industrial furnace (black body) emitting radiation at 2150°C.

PART B — (5 × 16 = 80 marks)

11. (a) 3 kg of air at 1.5 bar pressure and 77°C temperature at state 1 is compressed polytropically to state 2 at pressure 7.5 bar, index of compression being 1.2. It is then cooled at constant temperature to its original state 1. Find the net work done and heat transferred.

Or

(b) In a thermal power plant operating in steady state, an adiabatic steam turbine receives 1 kg/s of superheated steam at 3232 kJ/kg. The steam enters the turbine with a velocity of 10 m/s at an elevation of 10 m above the ground level. The steam leaves the turbine at 2345 kJ/kg. The velocity of the steam at the exit is 30 m/s and the exit is at an elevation of 4 m above the ground level.

(i) Calculate the power output of the turbine.

(ii) By ignoring the changes in kinetic energy and potential energy, what percentage error will be introduced?

12. (a) In a Diesel engine, the initial pressure and temperature of the air are 1 bar and 30°C. The cut-off is 10% of the stroke and it is 20 cm cylinder diameter and 30 cm stroke. Find

(i) Pressure and temperatures at all salient points (6)

(ii) Theoretical air standard efficiency (4)

(iii) The power developed by the engine if the working cycles per minute are 400. (6)

Assume the compression ratio is 16 and working fluid is air.

Or

(b) (i) Explain with neat sketches, the sequence of events in the working of a two stroke petrol engine. (8)

(ii) A gasoline engine has a volumetric compression ratio of 8. The air just before compression stroke prevails at 100 kPa and 298 K. subsequently, the pressure of air rises to 5000 kPa due to burning of gasoline fuel. Determine

(1) Peak temperature and pressure

(2) Thermal efficiency.

13. (a) (i) Explain the working of steam power plant with a layout. (6)

(ii) State various methods of governing of steam turbine. Explain any one method in detail.

Or

(b) (i) Explain with a help of neat diagram, any one high pressure boiler. (6)

(ii) In a thermal power plant, employing ideal Rankine cycle, superheated steam at 20 bar and 400°C is produced in the boiler and the condenser is operated at 0.2 bar. Calculate the quality of steam at the turbine outlet and thermal efficiency.

14. (a) The low pressure cylinder of a two-stage double-acting reciprocating air compressor running at 120 rpm has a 50-cm diameter and 75-cm stroke. It draws air at a pressure of 1 bar and 20°C and compresses it adiabatically to a pressure of 3 bar. The air is then delivered to the intercooler, where it is cooled at constant pressure to 35°C and is then further compressed polytropically (index $n = 1.3$) to 10 bar in high pressure cylinder. Determine the power required to drive the compressor. The mechanical efficiency of the compressor is 90 % and motor efficiency is 86%.

Or

(b) Sketch the layout of an air conditioning system and explain the functions of each component in it.

15. (a) A pipe consists of 100 mm internal diameter and 8 mm thickness carries steam at 170°C. The convective heat transfer coefficient on the inner surface of pipe is 75 W/m^{2}C. The pipe is insulated by two layers of insulation. The first layer of insulation is 46mm in thickness having thermal conductivity of 0.14 W/m°C. The second layer of insulation is also 46 mm in thickness having thermal conductivity of 0.46 W/m°C. Ambient air temperature = 33°C The convective heat transfer coefficient from the outer surface of pipe = 12 W/m^{2}C. Thermal conductivity of steam pipe = 46 W/m°C. Calculate the heat loss per unit length of pipe and the interface temperatures.

Or

(b) Vertical door of a hot oven is 0.5 m high and is maintained at 200°C. It is exposed to atmospheric air at 20°C. Find the heat transfer coefficient for the door and the rate of heat transfer.

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