CBCS SCHEME

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17ME43

Fourth Semester B.E. Degree Examination, Aug./Sept. 2020
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of thermodynamic data hand book is permitted.***

Module-1

1 a. State any 2 assumptions for Air Standard Cycle and obtain air standard efficiency expression for diesel cycle. **(10 Marks)**

b. An air standard limited pressure cycle has a compression ratio of 15 and compression begins at 0.1 MPa, 40°C. The maximum pressure is limited to 6 MPa and the heat added is 1.675 MJ/kg. Compute (i) The heat supplied at constant volume per kg of air (ii) The heat supplied at constant pressure per kg of air (iii) The cycle efficiency (iv) The cut-off ratio (v) The M.E.P of the cycle. **(10 Marks)**

OR

2 a. With the help of line diagram and T-S diagram, explain intercooling and reheating in gas turbine cycles. **(10 Marks)**

b. A gas turbine working on Brayton cycle receives air at 1 bar and 27°C . The air is compresed adiabatically to 6.2 bar with efficiency of the compressor being 88%. The fuel has a heating value of 44180 kJ/kg and the fuel air ratio is 0.017 kg fuel/kg air. The efficiency of the turbine is 90%. Calculate (i) Compressor work (ii) Turbine work and (iii) Thermal efficiency. **(10 Marks)**

Module-2

3 a. Explain the types of feed water heater using flow and T-S diagram. **(10 Marks)**

b. A turbine is supplied with steam at a pressure of 32 bar and temperature of 410°C. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle.
If the steam is reheated at 5.5 bar to a temperature of 400°C and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle. **(10 Marks)**

OR

4 a. Discuss the effect of condenser pressure and Boiler pressure in Rankine cycle. **(08 Marks)**

b. Write any two desirable characteristics of the working fluid used in vapour power cycle. **(02 Marks)**

c. A 40 MW steam power plant working on Rankine cycle operates between boiler pressure of 4 MPa and condenser pressure of 10 KPa. The steam leaves the boiler and enters the steam turbine at 400°C. The isentropic efficiency of the steam turbine is 85%.
Determine (i) The cycle efficiency (ii) The quality of exhaust steam from the turbine and (iii) the steam flow rate in kg per hour. Consider pumpwork. **(10 Marks)**

Module-3

5 a. Define stoichimetric air, actual air, excess air and combustion efficiency. **(08 Marks)**

b. Calculate the air-fuel ratio for burning of propane (C_3H_8) with 130 percent theoretical air. **(08 Marks)**

c. Explain Detonation in SI engine. **(04 Marks)**

OR

6 a. With P-θ diagram, explain the stages of combustion in SI engine. **(08 Marks)**

b. In a test on a 3-cylinder, 4-stroke IC engine with 22 cm bore and 26 cm stroke, the following were the observations during a trail period of one hour.
Fuel consumption = 8 kg, Calorific value = 45000 kJ/kg
Total revolutions of the Crankshaft = 12000
Mean effective pressure = 6 bar
Net load on brake = 1.5 kN
Brake drum diameter = 1.8 m, Rope diameter = 3 cm
Mass of cooling water = 550 kg
Inlet temperature of water = 27°C
Exit temperature of water = 55°C
Air consumed = 300 kg, Ambient temperature = 30°C
Exhaust gas temperature = 310°C
Specific heat of gases = 1.1 kJ/kg K
Calculate (i) Indicated and brake power (ii) Mechanical efficiency
(iii) Indicated thermal efficiency
Also draw a heat balance sheet on minute and percent basis. **(12 Marks)**

Module-4

7 a. Explain any two factors affecting the performance of a simple vapour compression system. **(06 Marks)**

b. With a neat sketch, explain steam jet refrigeration. **(06 Marks)**

c. A simple vapour compression plant produces 5 tonnes of refrigeration. The enthalpies of the working fluid at inlet to the compressor, at exit of compressor and at exit from the condenser are 183.19 KJ/kg, 209.41 KJ/kg and 74.59 KJ/kg respectively. Estimate (i) The refrigerant flow rate (ii) COP of the plant (iii) Power required to drive the compressor and (iv) the rate of heat rejection in the condenser. Assume that vapour is dry saturated at the end of compression. **(08 Marks)**

OR

8 a. Explain the following: (i) Adiabatic mixing of air (ii) Heating and Humidification (iii) Cooling and dehumidification. **(12 Marks)**

b. The dry and the wet bulb temperature of atmosphere air at 1 atm (101.325 KPa) pressure are measured with a sling psychrometer and determined to be 25 and 15°C respectively. Determine (i) Specific humidity (ii) Relative humidity (iii) The enthalpy of air (iv) DPT. Use properties of table only. **(08 Marks)**

Module-5

9 a. Derive an expression for workdone with clearance volume. **(08 Marks)**

b. A single acting air compressor has a cylinder bore of 15 cm and a piston stroke of 25 cm. The crank speed is 600 rpm. Air taken from atmosphere (1 bar and 27°C) is delivered at 11 bar. Assuming that both the compression and expansion processes are according to the law $PV^{1.25}$ = constant and the clearance is 5%. Determine (i) Power required to drive the compressor, assuming mechanical efficiency as 80% (ii) The time required to deliver 1 m^3 of air as measured at compressor outlet conditions, (iii) Volumetric efficiency. **(12 Marks)**

OR

10 a. Explain the shapes of nozzle. **(06 Marks)**

b. In a 2-stage air compressor, the work output is found to be 350 KJ/kg of air. It is used to compress 1 kg of free air from 1 bar pressure and 32°C initial temperature. The value of n = 1.3 and R = 0.287 KJ/kgK. Find the intermediate pressure. **(06 Marks)**

c. Obtain an expression for volumetric efficiency of compressor. **(08 Marks)**

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