CBCS SCHEME

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17ME43

Fourth Semester B.E. Degree Examination, Feb./Mar. 2022
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 Steam Table/Mollier chart/Psychrometric chart is permitted.

Module-1

1 a. Derive an expression of air-standard efficiency of an Otto cycle with PV and TS diagram. **(08 Marks)**

b. An engine working on a dual combustion cycle takes in air at 1 bar and 30°C. The clearance is 80% of the stroke and the cut-off takes place at 10% of the stroke. The maximum pressure in the cycle is limited to 70 bar. Find the temperature and pressure at all salient points. Also find air standard efficiency. **(12 Marks)**

OR

2 a. With a help of block diagram and TS diagram, explain regeneration process. **(08 Marks)**

b. Find the required air fuel ratio in a gas turbine whose turbine and compressor efficiencies are 85% and 80% respectively. Maximum cycle temperature is 875°C. The working fluid can be taken as air [C_p = 1.0 kJ/kgK and γ = 1.4] which enters the compressor at 1 bar and 27°C. The pressure ratio is 4. The fuel used has a CV of 42000 kJ/kgK. There is a loss of 10% of fuel in the combustion chamber. **(08 Marks)**

c. Briefly classify the jet propulsion engine. **(04 Marks)**

Module-2

3 a. With the help of T-S diagram, explain the effect of :
(i) Pressure and temperature
(ii) Super heating
(iii) Boiler pressure on the performance of Rankine cycle **(09 Marks)**

b. Assuming that steam enters the turbine in a dry saturated state, show that for a simple Rankine cycle the thermal efficiency of the cycle is given by

$$\eta = 1 - \frac{T_l}{T_m}$$

where T_l = Heat rejection temperature
T_m = Thermodynamic mean temperature **(06 Marks)**

c. In a regenerative cycle, the steam pressure at turbine inlets is 30 bar and the exhaust is at 0.04 bar. The steam is initially saturated. Enough amount of steam is bled off at the optimum pressure to heat the feed water. Neglecting pump work, determine the cycle efficiency. **(05 Marks)**

OR

4 a. With a help of block diagram and TS diagram, explain briefly the Carnot cycle. Also derive an expression for the thermal efficiency of Carnot cycle. **(10 Marks)**

b. A Rankine cycle working between a boiler pressure of 30 bar and condenser pressure of 0.5 bar. The mass leaving the boiler and entering the turbine has a dryness fraction of 0.85. Determine: (i) Rankine cycle efficiency (ii) Turbine work (iii) Pump work **(10 Marks)**

Module-3

5 a. Explain:
(i) Mass and mole fraction
(ii) Stoichiometric air fuel ratio for petrol
(iii) Enthalpy and internal combustion **(06 Marks)**

b. Explain the analysis of exhaust gases by Orsat apparatus. **(05 Marks)**

c. The given percentage composition by a mass of fuel is given as follows: C = 90%, H_2 = 3.3%, O_2 = 3%, N_2 = 1.1% and S = 0.91% and the remainder is incombusitible. Find:
(i) The mass of air required for combustion of 1 kg of fuel.
(ii) If 60% excess air is used, determine the percentage of exhaust gases by volume. **(09 Marks)**

OR

6 a. Define knocking in SI engine. Explain the factors affecting knocking. **(04 Marks)**

b. With a block diagram, explain Morse test on multi-cylinder engine. **(06 Marks)**

c. The following results were obtained during a test on a two stroke engine at full load.
Fuel consumption = 4 kg/hr
Cylinder diameter = 20 cm
Stroke = 28 cm
Speed = 350 rpm
Net brake load = 630 N
Mean effective pressure = 300 kPa
Jacket cooling water flow rate = 500 kg/hour
Jacket cooling water temperature rise = 20°C
Temperature of exhaust gases = 400°C
Room temperature = 20°C
Air used per kg of fuel = 32 kg
Effective brake diameter = 100 cm
Calorific value of fuel = 43 MJ/kg
Proportion of hydrogen in fuel = 15%
Specific heat of dry exhaust gas = 1 kJ/kgK
Specific heat of steam = 2.1 kJ/kgK
Draw heat balance sheet in kJ/min and in percentage **(10 Marks)**

Module-4

7 a. With a neat sketch, explain air refrigeration system working on Bell-Coleman cycle. Also show its PV and TS diagram. **(06 Marks)**

b. Derive an expression for Coefficient of Performance (COP) when air refrigeration system when compression and expansion are isentropic. **(06 Marks)**

c. An air refrigeration system works on an open air cycle is required to provide 20 tonnes of refrigeration, with cooler pressure of 12.5 bar and refrigerator pressure of 1.05 bar. The temperature of the air leaving the cooler is 20°C and leaving the cold chamber is −1°C. Assuming isentropic compression and expansion and neglecting clearance. Find:
(i) Weight of air circulated/min
(ii) COP of the system
(iii) Power required per ton refrigeration **(08 Marks)**

OR

8 a. Define:
(i) Dry bulb temperature
(ii) Wet bulb temperature
(iii) Relative humidity **(03 Marks)**

b. Two air streams are mixed steadily and adiabatically. The first air stream enters at 32°C DBT and 40% RH while second enters at 12°C and 90% RH. The flow rates of the two streams are 20 m^3/min and 25 m^3/min respectively. Determine: (i) Specific humidity (ii) Relative humidity (iii) Flow rate after mixing **(12 Marks)**

c. Explain the various factors that determine the comfort of the people in an air conditioned space. **(05 Marks)**

Module-5

9 a. With a block diagram, explain multistage compressor. **(05 Marks)**

b. Derive an expression for workdone in a single stage compressor neglecting clearance. **(05 Marks)**

c. A two stage compressor with perfect intercooling takes in air at 1 bar pressure and 27°C. The law of compression in both stages is $PV^{1.3} = C$. The compressed air is delivered at 10 bar from the HP cylinder to an air receiver. Calculate per kg of air.
(i) The minimum work done
(ii) Heat rejected in the intercooler
(iii) The minimum work done in a 3-stage compressor under same condition **(10 Marks)**

OR

10 a. Explain steam nozzles and its various types. **(04 Marks)**

b. Derive an expression for exit velocity of steam flow through nozzle. **(08 Marks)**

c. Steam expands form 3 bar. The initial velocity if 90 m/sec and the initial temperature is 150°C. The nozzle efficiency is 0.95. Determine the exit velocity. **(08 Marks)**

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