CBCS SCHEME

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18ME42

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
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 handbook and steam tables permitted.

Module-1

1 a. What is an Air standard efficiency? Derive an expression for air standard efficiency of Diesel cycle. **(10 Marks)**

b. A certain quantity of air at a pressure of 1 bar and 27°C is compressed isentropically until pressure reaches to 7bar in an otto cycle engine 400kJ of heat added per kg of air at constant volume. Determine:
i) Compression ratio
ii) Temperature at the end of each process
iii) Air standard efficiency. Take $C_v = 0.714$kJ/kg-K. **(06 Marks)**

c. Compare the air standard efficiencies of the Otto and Diesel cycle for the same compression ratio. **(04 Marks)**

OR

2 a. Classify the I.C. Engine. **(04 Marks)**

b. Describe the followings as applied to I.C. Engine: i) Morse Test ii) Heat balance sheet. **(08 Marks)**

c. The following data were recorded in a test one hour duration on single cylinder oil engine working on 4-stroke cycle. bore = 300mm, stroke = 450mm, fuel used = 8.8kg, C.V. = 41800kJ/kg, speed = 200rpm, mean effective pressure (M.E.P.) = 5.8 bar, brake friction load = 1860N, quantity of cooling water = 650kg, temperature rise = 22°C. Diameter of brake wheel = 1.22m. Calculate:
i) Mechanical efficiency
ii) Brake thermal efficiency
iii) Draw heat balance sheet on hour basis. **(08 Marks)**

Module-2

3 a. Discuss the following with the help of T-S diagram and schematic diagram:
i) Regeneration
ii) Intercooling
iii) Reheating. **(12 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 whose $C_p = 1.0$kJ/kg-K and $\gamma = 1.4$ which enters the compressor at 1 bar and 27°C. The pressure ratio is 4. The fuel has calorific value of 42000 kJ/kg. There is loss of 10% calorific value in the combustion chamber. **(08 Marks)**

OR

4 a. With neat sketch, explain working of Ramjet and Turboprop engine. **(10 Marks)**

b. In a constant pressure open cycle gas turbine air enters at 1 bar and 20°C and leaves the compressor at 5 bar. Using the following data:
Temperature of gases entering the turbine = 680°C, pressure loss in the combustion chamber = 0.1 bar, compressor and turbine efficiencies are 85% and 80% respectively, $\gamma = 1.4$, $C_p = 1.024$kJ/kg-K for air and gas, find:
   i) The quantity of air circulation if the plant develops 1065kW
   ii) Heat supplied per kg of air circulation
   iii) The thermal efficiency of the cycle mass of the fuel way be neglected.
   Take combustion efficiency $\eta_{comb} = 85\%$. **(10 Marks)**

Module-3

5 a. Compare the Rankine and the Carnot vapor power cycles. **(04 Marks)**

b. What is reheating of steam? Explain reheating cycle of steam with the help of block diagram and T-S diagrams. Also derive an expression for its thermal efficiency. **(08 Marks)**

c. Steam turbine receives steam at 15bar and 300°C and leaves at the turbine is 0.1 bar and steam contains 4% moisture. Determine:
   i) Efficiency
   ii) Work ratio
   iii) Specific steam consumption. The specific heat of steam $C_{P_s} = 2.1\text{kJ/kg} - \text{K}$. **(08 Marks)**

OR

6 a. Why Carnot cycle is not used as a reference cycle for steam power plant? **(03 Marks)**

b. Discuss the effect of
   i) Boiler pressure
   ii) Condenser pressure
   iii) Superheat on the performance of a Rankine cycle. **(09 Marks)**

c. The steam at 80 bar and 500°C expands in the turbine upto 8 bar with an isentropic efficiency of 85%. The steam is then reheated to original temperature and then it expands in the lower stages of the turbine upto the condenser pressure of 0.05 bar. The isentropic efficiency of the lower stages of the turbine is 90%. Find the thermal efficiency of the cycle assuming there is no pressure drop in the reheater. Neglect the pump work. **(08 Marks)**

Module-4

7 a. With neat sketch, explain vapor refrigeration cycle. **(06 Marks)**

b. State merits and demerits of an air refrigeration system. **(06 Marks)**

c. An ammonia refrigerator produces 30 tonnes of ice at 0°C from water at 20°C in a day. The temperature range of working cycle is 25°C to -15°C. The vapor is dry saturated at the end of compression. Assuming actual COP of 60% of theoretical. Calculate the power required to drive compressor. Latent heat of ice is 335kJ/kg. Use following properties of ammonia. **(08 Marks)**

Temperature	Enthalpy		Entropy	
	Liquid	Vapor	Liquid	Vapor
25°C	100.04	1319.22	0.3473	4.4852
-10°C	-54.58	1304.99	-2.134	5.0585

OR

8 a. Define the following:
i) Dry Bulb Temperature (DBT)
ii) Degree of Saturation
iii) Relative Humidity
iv) Dew Point Temperature (DPT) **(06 Marks)**

b. With neat sketch, explain natural draught cooling tower. **(06 Marks)**

c. An air stream of 24°C DBT and 22°C WBT is mixed with fresh air of 32°C DBT and 70% RH. The volume flow rates of streams is 200m^3/min and 850m^3/min respectively. Determine specific humidity, enthalpy and DPT of mixture. **(08 Marks)**

Module-5

9 a. Derive an expression for minimum work required by a two stage air compressor with perfect inter cooling between two stages. **(08 Marks)**

b. Why multistage compressors are preferred over single stage compressor? **(04 Marks)**

c. For a single stage single acting reciprocating air compressor, actual volume of air taken in it is 10m^3/min. Initial intake pressure is 1.013 bar and initial temperature is 27°C. Final pressure is 900kPa. Clearance is 6% of stroke. Compressor run's at 400rpm. Assume (L/D) = 1.25 and index of compression = 1.3. Determine:
i) Volumetric efficiency
ii) Cylinder dimension
iii) Indicated power. **(08 Marks)**

OR

10 a. Derive an expression for steam velocity coming out from a nozzle. **(04 Marks)**

b. What is effect of friction on the flow through a steam nozzle? Explain with the help of h-s diagram. **(08 Marks)**

c. Dry saturated steam enters a steam nozzle of a pressure of 15 bar and discharged at a pressure of 2 bar. If the dryness fraction of the steam is 0.96 what will be final velocity of steam? Neglect initial velocity of steam. If 15% of heat drop is lost in friction. Find the percentage reduction in final velocity. **(08 Marks)**

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