CBCS SCHEME

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18ME42

Fourth Semester B.E. Degree Examination, July/August 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 Thermodynamics data hand book is permitted.***

Module-1

1 a. Derive an expression of air standard efficiency of diesel cycle with neat PV and T-S diagrams. **(10 Marks)**

b. An engine with 200mm cylinder diameter and 300mm Stroke length works on diesel cycle. The initial pressure and temperature of air are 0.1 MPa and 27°C. The cutoff is 8% of Stroke volume and compression ratio is 15. Determine :
i) Pressure and temperature at all salient points ii) Air standard efficiency. **(10 Marks)**

OR

2 a. Explain any two methods of deeming frictional power. **(08 Marks)**

b. The following observations were made during one hour test on a single Stroke oil engine.
Bore = 300mm ; Stroke = 450mm ; mass of fuel used = 8.8Kg ;
Calorific value = 41800kJ/Kg ;
Average speed = 200rpm, Mean effective pressure = 5.8 bar, Brake load = 1860N, Mass of cooling water = 650Kg, Temperature rise = 22°C, Diameter of Brake drum = 1.22 m.
Calculate: i) Mechanical efficiency ii) Brake thermal efficiency iii) Draw heat balance sheet on kJ/hr basis. **(12 Marks)**

Module-2

3 a. Derive an expression of optimum pressure ratio for maximum workout put in case of actual Brayton cycle. **(10 Marks)**

b. Air enters the compressor of a gas turbine plant operating on Brayton cycle at 101.325KPa, 27°C. The pressure ratio in the cycle is 6. Calculate the maximum temperature in the cycle and cycle efficiency. Assume $W_T = 2.5W_c$. Where W_T and W_C are the turbine and compressor work respectively. Take r = 1.4. **(10 Marks)**

OR

4 a. With a neat block diagram and T-S diagram, explain how 'regeneration' increases thermal efficiency of gas turbine plant. **(08 Marks)**

b. Air is drawn in a gas turbine unit at 15°C and 1.01bar and pressure ratio is 7. The compressor is driven by the high pressure turbine and low pressure turbine drives a separate shaft. The isentropic efficiencies of compressor and HP and LP turbines are 0.82, 085 and 0.85 respectively. If the maximum cycle temperature is 610°C, find :
i) The pressure and temperature of the gases entering the power turbine
ii) The net power developed by the unit per Kg/sec mass flow.
iii) Work ratio
iv) Thermal efficiency of the unit
Neglect the mass of the fuel and assume the following :
For compression process, $C_{Pa} = 1.005$ kJ/Kg.K and r = 1.4.
For combustion and expansion process : $C_{pg} = 1.15$ kJ/Kg.K and r = 1.33. **(12 Marks)**

Module-3

5 a. Discuss the effect of i) Boiler pressure ii) Condenser pressure iii) Super heat on the performance of a Rankine cycle. **(10 Marks)**

b. Steam at 1 bar and 350°C is expanded in a steam turbine to 0.08bar. It them enters the condenser, where it is condensed to saturated liquid water. Assume the turbine and feed pump efficiencies as 80% and 90% respectively. Determine per Kg of steam the network, the heat transferred to the working fluid and Rankine efficiency. **(10 Marks)**

OR

6 a. Sketch and explain the flow diagram and corresponding T-S diagram of practical regenerative Rankine cycle. **(10 Marks)**

b. A reheat cycle has the first stage supply conditions of 70bar and 500°C. The reheat is at 3 bar and to the same temperature.

i) Given that the efficiency of the first stage turbine is 80%, how much energy is added per kg of steam in the reheat coils?

ii) Assume that the same expansion efficiency exists in the second turbine. What is the thermal efficiency, if the condenser pressure is 0.03 bars? **(10 Marks)**

Module-4

7 a. Explain the effect of super heating and under cooling the refrigerant on the performance of vapour compression refrigeration cycle. **(06 Marks)**

b. What are the properties of refrigerants? **(04 Marks)**

c. A vapour compression refrigerator uses methyl Chloride (R – 40) and operates between the temperature limits of -10°C and 45°C. At the entry to the compressor the refrigerant is dry saturated and after the compression it acquires a temperature of 60°C. Find COP of the refrigerator. The relevant properties of R – 40 are as follows :

Saturation temperature	Enthalpy		Entropy	
	Liquid	Vapour	Liquid	Vapour
-10°C	45.4	460.7	0.183	1.637
45°C	133	483.6	0.485	1.587

Also find mass of methyl chloride and power required for a capacity of 15 TOR. **(10 Marks)**

OR

8 a. Define : i) Wet bulb temperature ii) Dew point temperature iii) Relative humidity iv) Specific humidity v) Degree of saturation. **(10 Marks)**

b. Air is to be conditioned from 40° C (DBT) and 50% RH to a final temperature of 20°C (DBT) and 40% RH, by de-humidification process, followed by a reheat process. Assuming that the entire process is at constant pressure of 101.325 KPa, determine :

i) The amount of water to be removed from air

ii) The temperature of air leaving the dehumidifier

iii) Refrigeration in tons for air flow rate of $0.47 m^3/sec$

iv) Heating required in kW. **(10 Marks)**

Module-5

9 a. Derive an expression for minimum work input by two stage compressor with intercooler. **(10 Marks)**

b. A single stage single acting reciprocating air compressor has a bore of 200mm and Stroke of 300mm. It receives air at 1 bar and 20°C and delivers it at 5.5 bar. If the compression follows the law $PV^{1.3} = C$ and clearance volume is 5% of the Stroke volume, determine :

i) Mean effective pressure

ii) Power required to drive the compressor if it runs at 500rpm. **(10 Marks)**

OR

10 a. Derive an expression of critical pressure ratio which gives maximum discharge through the nozzle. **(10 Marks)**

b. Steam at 15bar and 250°C is expanded in a nozzle to 1 bar. For a discharge of 0.5kg/sec find throat and exit diameter for maximum discharge conditions. Assume the nozzle efficiency as 90%. **(10 Marks)**

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