CBCS SCHEME

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17ME43

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 Steam Tables / Mollier chart / Psychrometric chart is permitted.***

Module-1

1 a. Derive an expression for an air standard efficiency of diesel cycle with neat sketch of PV and TS diagram. State the assumptions made to formulate this expression. **(10 Marks)**

b. In an air standard dual cycle, the air is at a pressure of 100 kPa and a temperature of 27°C before the isentropic compression begins. In this process, the volume of air is reduced from 0.07 m^3 to 0.004 m^3. During the process of heat addition at constant pressure, the temperature of the air is increased from 1160°C to 1600°C. Determine:
(i) Compression ratio (ii) Cutoff ratio
(iii) Thermal efficiency (iv) Mean effective pressure **(10 Marks)**

OR

2 a. Explain in detail with TS diagram, how the following methods are employed to improve the performance of gas turbine. (i) Regeneration (ii) Reheating **(10 Marks)**

b. A gas turbine has a minimum and maximum temperature of 60°C and 900°C. The compressor and the turbine efficiencies are 0.80 and 0.85 respectively. Estimate the condition for maximum net work done. Also, calculate the net work done and the thermal efficiency. The pressure at the inlet of the compressor is 1 bar. **(10 Marks)**

Module-2

3 a. A steam power plant is working on simple ideal Rankine cycle with fixed inlet temperature and condenser pressure. Explain with TS diagram, the effect of following factors on the turbine work output, heat supplied, cycle efficiency and the steam quality at the turbine exit.
(i) Boiler pressure (ii) Super heating the steam **(10 Marks)**

b. A steam power plant operates on a Rankine cycle between the pressure limits of 17500 kPa and 10 kPa. The peak temperature is 500°C. If the adiabatic efficiency of the turbine is 80% and the adiabatic pump efficiency is 85%. Determine the thermal efficiency and the specific steam consumption. **(10 Marks)**

OR

4 a. With a neat schematic layout and TS diagram, explain how the performance of steam power plant change, when a simple Rankine cycle is modified with Reheater. **(10 Marks)**

b. Consider a steam power plant operating on an ideal Reheat Rankine cycle. Steam enters the high pressure turbine at 15 MPa and 600°C and is condensed in the condenser at a pressure of 10 kPa. If the moisture content of the steam at the exit of low pressure turbine is not to exceed 10.4%, determine: (i) Pressure at which the steam should be reheated (ii) Thermal efficiency of the cycle. Assume the steam is reheated to the inlet temperature of the high pressure turbine. **(10 Marks)**

Module-3

5 a. Define and briefly explain the following terms related to combustion thermodynamics:
(i) Excess air
(ii) Enthalpy of formation
(iii) Internal energy of combustion
(iv) Combustion efficiency
(v) Adiabatic flame temperature **(10 Marks)**

b. The products of combustion of an unknown hydrocarbon C_xH_y have the following composition measured by Orsat apparatus.
$CO_2 = 8\%$, $CO = 0.9\%$, $O_2 = 8.8\%$, $N_2 = 82.3\%$
Determine:
(i) The composition of fuel
(ii) Air fuel ratio
(iii) The percentage of excess air
(iv) Dew point temperature of the products if the total pressure is 1.01325 bar. **(10 Marks)**

OR

6 a. Explain the following methods of determining frictional power of an engine:
(i) Motoring test
(ii) Morse test **(10 Marks)**

b. The following observations are recorded in a test of one hour duration on a single cylinder, 4 stroke SI engine; Bore = 220 mm, stroke = 300 mm, fuel used = 4 kg, calorific value of fuel = 42000 kJ/kg, speed = 300 rpm, MEP = 5 bar, load on brake = 600 N, spring balance reading = 30 N, diameter of the brake drum = 1.4 m, quantity of cooling water = 500 kg/hr, temperature rise of cooling water = 20°C, air fuel ratio = 16, C_p of gases = 1.1 kJ/kgK, ambient temperature = 30°C, exhaust gas temperature = 410°C. Calculate the following:
(i) Brake thermal efficiency
(ii) SFC
Also draw heat balance sheet in kJ/min. **(10 Marks)**

Module-4

7 a. With a schematic diagram, explain the working of a vapour absorption refrigeration system. **(08 Marks)**

b. A 10 TR Ammonia ice plant operates between an evaporator temperature of –15°C and condenser temperature of 35°C. The ammonia enters the compressor as dry saturated vapour. Assuming isentropic compression. Determine:
(i) Mass flow rate of ammonia
(ii) COP of plant
(iii) Power input
(iv) Tonnes of ice at –10°C produced from water at 25°C in a day.
Take C_P of ammonia vapour = 4.81 kJ/kgK, $h_{fg(ice)}$ = 335 kJ/kg, $C_{P(ice)}$ = 2.1 kJ/kgK, $C_{P(water)}$ = 4.2 kJ/kgK. **(12 Marks)**

OR

8 a. With a neat sketch, explain the working of a summer air conditioning system for hot and dry weather. Represent the various processes of the system on a psychrometric chart. **(10 Marks)**

b. For a hall to be air conditioned, the following conditions are given:
Outdoor conditions = 40°C DBT, 20°C WBT
Required comfort conditions = 20°C DBT, 60% RH
Seating capacity of the hall = 1500
Amount of outdoor air supplied = 0.3 m^3/min/person.
If the required condition is achieved first by adiabatic humidification and then by cooling, estimate:
(i) Capacity of cooling coil in TR
(ii) Capacity of the humidifier in kg/hr
(iii) Condition of air after adiabatic humidification. **(10 Marks)**

Module-5

9 a. Derive the condition for minimum work in a 2 stage reciprocating air compressor. Using this condition obtain the expression for minimum work in a two stage compression. **(12 Marks)**

b. A single stage single acting compressor delivers 0.6 kg of air/minute at 6 bar pressure. The temperature and pressure at the end of suction stroke are 30°C and 1 bar. The bore and stroke of the compressor are 100 mm and 150 mm respectively. The clearance is 3% of swept volume. Assuming the index of compression and expansion to be 1.3, find:
(i) Volumetric efficiency of the compressor
(ii) Power required if the mechanical efficiency is 0.85
(iii) Speed of the compressor **(08 Marks)**

OR

10 a. Explain the following types of flows in a steam nozzle:
(i) Isentropic flow
(ii) Flow with friction
(iii) Super saturated flow **(10 Marks)**

b. A convergent divergent nozzle is required to discharge 360 kg/hr of steam. The nozzle is supplied with steam at 10 bar and 0.97 dryness and discharges against a back pressure of 0.5 bar. Neglecting the effect of friction, find the throat and the exit diameter. Assume the condition for maximum discharge. **(10 Marks)**

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