CBCS SCHEME

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18MR43

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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 and gas tables is allowed.***

Module-1

1 a. With the help of P-V diagram and T-S diagram, compare Otto, diesel and dual cycles, when heat supplied to each cylinder is same. **(10 Marks)**

b. The pressure and temperature at the beginning of compression in an air standard Otto cycle are 102 kPa and 315 K. Heat is added during the process at the rate of 250 kJ/kg of air and air is used with a compression ratio of 9. Assuming $\gamma = 1.4$ and $R = 287$ J/kgK for air, determine:
(i) The thermal efficiency of the cycle
(ii) The maximum cycle temperature
(iii) The maximum cycle pressure
(iv) The mean effective pressure **(10 Marks)**

OR

2 a. With the help of T-S and P-V diagrams, derive an expression for the air standard efficiency of a diesel cycle. **(10 Marks)**

b. An engine of 250 mm bore and 375 mm stroke works on constant volume cycle. The clearance volume is 0.00263 m^3. The initial pressure a temperature are 1 bar 950°C. If maximum pressure is 25 bar, find:
(i) Air standard efficiency of the cycle (ii) Mean effective pressure **(10 Marks)**

Module-2

3 a. Derive an expression for the efficiency of Rankine cycle with the help of neat sketches. State the advantages and disadvantages of reheating and regeneration over a simple Rankine cycle. **(10 Marks)**

b. Assume that the steam power plant works on simple Rankine cycle between the boiler pressure of 3 MPa and condenser pressure of 4 kPa and the steam is dry saturated before the throttling in the turbine, determine:
(i) Rankine cycle efficiency
(ii) Work ratio
(iii) Specific steam consumption **(10 Marks)**

OR

4 a. Sketch the flow diagram and the corresponding temperature entropy diagram of a reheat cycle and derive an expression for reheat cycle efficiency. **(10 Marks)**

b. To improve the existing efficiency, a steam power plant incorporates an ideal reheat cycle. Steam at 30 bar and 250°C is supplied at the high pressure turbine inlet and expands till it is dry saturated at 3 bar. Now the steam is taken to a reheater and its temperature is again increased to 250°C at constant pressure reheating process. The reheated steam expands in the low pressure turbine to a condenser pressure of 0.04 bar. Determine the cycle efficiency. **(10 Marks)**

Module-3

5 a. Explain the following:
(i) Enthalpy of combustion
(ii) Internal energy of combustion
(iii) Theoretical air for combustion of fuel
(iv) Enthalpy of formation **(10 Marks)**

b. A sample of fuel has the following composition:
Hydrogen 8%, Sulphur 3%, Carbon 86%, Oxygen 2%, Ash 1%. For an air fuel of 12:1, calculate:
(i) Mixture strength as a percentage rich or weak
(ii) Volumetric analysis of the dry products of combustion **(10 Marks)**

OR

6 a. With neat sketch, explain exhaust gas analysis. **(10 Marks)**

b. Methane (CH_4) is burned with atmospheric air. The analysis of the products of combustion on a dry basis is as follows:
$CO_2 = 10.00\%$, $O_2 = 2.37\%$, $CO = 0.53\%$ and $N_2 = 87.10\%$.
Calculate the air fuel ratio and the percent theoretical air and determine the combustion equation. **(10 Marks)**

Module-4

7 a. With the neat sketch, explain: (i) Motoring method (ii) Willan's line method **(10 Marks)**

b. In a test of 4-cylinder, 4 stroke petrol engine of 75 mm bore and 100 mm stroke. The following results were obtained at full throttle at a constant speed and with a fixed setting of the fuel supply at 0.082 kg/min. BP with all the 4 cylinders working = 15.24 KW, BP with cylinder No.1 cutoff = 10.45 KW, BP with cylinder No.2 cutoff = 10.38 KW, BP with cylinder No.3 cutoff = 10.23 KW, BP with cylinder No.4 cutoff = 10.45 KW. Determine:
(i) The indicated power
(ii) The indicated thermal efficiency, if the calorific value of the fuel = 44 MJ/kg.
(iii) Relative efficiency based on IP if clearance volume in each cylinder = 115 cc.
(10 Marks)

OR

8 a. Explain the following:
(i) Morse test
(ii) Heat balance sheet **(10 Marks)**

b. The following observations were made during one hour test on a single cylinder 4-stroke oil engine. Bore = 300 mm, stroke = 450 mm, mass of fuel used = 8.8 kg, calorific value = 41800 kJ/kg, average speed = 200 rpm, mean effective pressure = 5.8 bar, brake load = 1860 N, mass of cooling water circulated = 650 kg, temperature rise = 22°C, diameter of brake drum = 1.22 m. Calculate:
(i) Mechanical efficiency
(ii) Brake thermal efficiency
(iii) Draw the heat balance sheet **(10 Marks)**

Module-5

9 a. With neat sketch, explain steam jet refrigeration. (10 Marks)

b. It is required to design an ideal air refrigeration cycle according to the following specifications:

Pressure of air at compression inlet = 103.42 kPa

Pressure of air at turbine inlet = 413.7 kPa

Temperature of air at compressor inlet = –7°C

Temperature of air at turbine inlet = 27°C

Determine:

(i) The C.O.P of the cycle

(ii) The power required to produce 1 ton of refrigeration

(iii) The air-circulation rate for each ton of refrigeration.

Assuming $PV^{r} = C$ and $\gamma = 1.4$ for expansion and compression. (10 Marks)

OR

10 a. Define the following:

(i) Dew point temperature

(ii) Dry bulb temperature

(iii) Relative humidity

(iv) Specific humidity

(v) Degree of saturation (10 Marks)

b. A mixture of dry air and water vapour is at a temperature is 16°C. Find:

(i) Partial pressure of water vapour at 22°C

(ii) Saturation pressure of water vapour at 22°C

(iii) Specific humidity

(iv) Mass of water vapour a dry air

(v) Relative humidity

(vi) Degree of saturation (10 Marks)

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