CBCS SCHEME

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17ME43

Fourth Semester B.E. Degree Examination, June/July 2019
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 hand book is permitted.

Module-1

1 a. Draw neat P-V and T-S diagram of air standard dual cycle and derive an expression for air standard efficiency in terms of compression ratio, explosion ratio and cut-off ratio. Under what conditions the dual cycle becomes Otto and Diesel cycle. **(10 Marks)**

b. An air standard diesel cycle has a compression ratio 16. The temperature before compression is 27°C and the temperature after expansion is 627°C. Compute:
i) Cut-off ratio
ii) The net work output per unit mass of air
iii) Thermal efficiency
iv) Mean effective pressure in bar. **(10 Marks)**

OR

2 a. Explain with schematic diagram and T-S diagram Brayton cycle with i) Regenerator and ii) Inter-cooler and write equation for the thermal efficiency. **(10 Marks)**

b. Derive an expression for optimum pressure ratio and maximum pressure ratio for maximum work output in terms of minimum temperature, maximum temperature of Brayton cycle and what is the relation between the two. **(10 Marks)**

Module-2

3 a. With the help of schematic diagram, T-S diagram and h-s diagram, explain regenerative vapour power cycle with one open feed water heater and derive an expression for its thermal efficiency. **(10 Marks)**

b. A simple Rankine cycle works between the boiler pressure of 30bar and condenser pressure of 0.04Bar. The supply steam to the turbine is drysaturated, determine Rankine cycle efficiency. If the supply steam to the turbine is superheated by 66°C, what is the effect on the Rankine efficiency? **(10 Marks)**

OR

4 a. With the help of schematic diagram and T-S diagram explain binary vapour power cycle. List the properties of an ideal binary fluid. **(10 Marks)**

b. A reheat cycle operating between 30 bar and 0.04 bar pressure. The temperature of steam supplied from boiler is 450°C. The first stage of expansion takes place till the steam is dry saturated and then reheated to 450°C and then expanded in second in stage.
Determine:
i) Reheat pressure
ii) Quality of exhaust steam
iii) Ideal cycle efficiency
iv) Steam Rate
v) Back-pressure ratio. **(10 Marks)**

Module-3

5 a. List the methods used for finding out indicated power of an internal combustion engine. Explain the method applicable to multi-cylinder engine. **(08 Marks)**

b. The products of combustion of an unknown hydrocarbon C_xH_y have the following composition as measured by an Orsat's apparatus:
$CO_2 = 8\%$, $CO = 0.9\%$, $O_2 = 8.8\%$, $N_2 = 82.3\%$. Determine:
i) The composition of fuel
ii) A:F ratio
iii) The percentage excess air used. **(12 Marks)**

OR

6 a. Explain the following terms with reference to a combustion process:
i) Enthalpy of formation
ii) Adiabatic flame temperature
iii) Combustion efficiency
iv) Stoichiometric air. **(08 Marks)**

b. A gas engine working on constant volume cycle gave the following results during a one hour test run:
Cylinder diameter : 24cm, stroke 48cm, effective diameter of brake drum 1.25m, net load on the brake 1236N, Average speed 226.7 RPM, Average explosions per minute 77, MEP 7.5 bar, gas used 13m^3 at 15°C and 771 mm of mercury pressure, calorific value of gas 22000 kJ/m^3 at NTP. Cooling water used 625kg, rise in temperature of cooling water 35°C. Determine, mechanical efficiency, brake thermal efficiency indicated thermal efficiency, also draw up a heat balance sheet for the engine on percentage basis. Take NTP conditions as 760mm of mercury and 0°C. **(12 Marks)**

Module-4

7 a. With the help of schematic diagram and appropriate psychrometric diagram explain summer air conditioning system for hot and dry outdoor condition. **(10 Marks)**

b. A vapor compression plant uses R-12 and is to develop 5 tonnes of refrigeration. The condenser and evaporator temperature are to be 40°C and -10°C respectively. The vapor is dry saturated at compressor inlet and there is no under cooling. Determine:
i) Refrigerant flow rate in kg/sec
ii) The compressor discharge temperature
iii) The pressure ratio
iv) COP of the plant. **(10 Marks)**

OR

8 a. Explain the following with the help of P-h and T-S diagram the effect of under cooling the liquid refrigerant and super heating the vapor refrigerant on the performance of VCR cycle. **(10 Marks)**

b. It is required to design an air conditioning plant for a office room with the following conditions:
Outdoor conditions – 14°C DBT and 10°C WBT
Required conditions – 20°C DBT and 60% RH
Amount of air circulation – 0.30m^3/min/person
Seating capacity of office – 60 persons.
The required condition is achieved by heating and then by adiabatic humidification. Determine: i) Heating capacity of the coil in KW and surface temperature required if the bypass factor of the coil is 0.4 ii) The capacity of the humidifier. Also draw the flow diagram. **(10 Marks)**

Module-5

9 a. Obtain an expression for the volumetric efficiency of a single stage air compressor in terms of pressure ratio, clearance and 'h' the exponent of expansion and compression. Why intercooling is necessary in multistage compression? **(10 Marks)**

b. A singe stage single acting air compressor has cylinder bore of 15cm and Piston stroke of 25cm. The crank speed is 600rpm. The air taken from the atmosphere is at 1 bar and 27°C and delivered at 11 bar. Assuming both expansion and compression processes are according to the law $PV^{1.25}$ = constant and clearance is 5%. Determine: i) Power required to drive the compressor, assuming mechanical efficiency as 80%; ii) What will be change in power required to drive the compressor if clearance is 10% with other conditions remaining same. **(10 Marks)**

OR

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

b. The steam expands from 3 bar to 1 bar in a nozzle. The initial velocity is 90m/s and initial temperature is 150°C. Determine the exit velocity of steam:
i) If expansion is isentropic in nozzle
ii) The nozzle efficiency is 95%. **(10 Marks)**

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