U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: IV**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 19ME4DCATD/15ME4DCATD **Max Marks: 100**
Course: Applied Thermodynamics **Date: 12.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of Thermodynamics Data Handbook is permitted.
4. Use of steam tables, Mollier chart, Psychrometric chart and Refrigeration tables are permitted.

UNIT - I

1 a) Mention various assumption made in an air-standard cycle analysis. **04**

b) Derive an expression for the efficiency of Otto cycle and comment on the effect of compression ratio on the efficiency with respect of ratio of specific heats. **06**

c) In an engine working on diesel cycle inlet pressure and temperature are 1 bar and 17°C respectively. Pressure at the end of adiabatic compression is 35 bar. The cut-off ratio is 2.76. Calculate: i) the heat addition, ii) heat rejection, and iii) the efficiency of the cycle. Assume γ=1.4, C_p=1.004 kJ/kg K and C_v=0.717 kJ/kg K. **06**

d) A power plant operating on an ideal Brayton cycle has maximum cycle efficiency. Prove that the maximum pressure ratio is given by: $(r_p)_{max} = \left(\frac{T_{max}}{T_{min}}\right)^{\frac{\gamma}{\gamma-1}}$. Where $(r_p)_{max}$ is maximum pressure ratio, T_{max} and T_{min} are maximum and minimum temperature of the cycle and γ is the ratio of specific heats. **04**

UNIT - II

2 a) List out the different methods to determine the frictional power of an I.C. engine. Discuss briefly Motoring method of determining frictional power. **06**

b) What is meant by abnormal combustion? Explain phenomena of knock in SI engines. **04**

c) During the trial of single cylinder, four stroke oil engine, the following results were obtained: **10**

Cylinder diameter = 20 cm
Stroke = 40 cm
Mean effective pressure = 6 bar
Torque = 407 N-m
Speed = 250 rpm
Oil consumption = 4 kg/h
Calorific value of fuel = 43 MJ/kg
Cooling water flow rate = 4.5 kg/min
Air used per kg of fuel = 30 kg
Rise in cooling water temperature = 45°C
Temperature of exhaust gases = 420°C
Room temperature = 20°C
Mean specific heat of exhaust gases = 1 kJ/kg K
Specific heat of water = 4.18 kJ/kg K
Find: i) Indicated Power, ii) Brake Power, and iii) Draw the heat balance sheet for the test in kJ/h

UNIT - III

3 a) With the help of P-v diagram derive an expression for volumetric efficiency of a reciprocating air compressor. **06**

b) A single stage reciprocating air compressor takes air $1m^3$/min at 1.0132 bar and 15°C and delivers at 7 bar. If the speed of the compressor is 300 rpm. Assuming law of compression is $pv^{1.35}$=constant. Calculate: indicated power, ii) cylinder bore, assume stroke to bore ratio is 1.5, and power of the motor, if the mechanical efficiency is 85% and motor transmission efficiency is 90%. **08**

c) A multi-stage reciprocating compressor is designed to elevate pressure from 1 bar to 100 bar such that stage pressure ratio is not to exceed 4. Determine: i) number of stages, ii) exact stage pressure ratio, and iii) intermediate pressures. **06**

UNIT - IV

4 a) Draw p-v and p-T diagrams for pure substance and explain briefly. **06**

b) Define the following terms with respect to pure substances: i) subcooled liquid, ii) saturated liquid, iii) critical point, iv) triple point, v) sensible heat, vi) internal energy. **06**

c) A pressure cooker contains 1.5 kg of steam at 5 bar and 0.9 dryness. When the gas was switched off, determine the quality of heat rejected by the pressure cooker when the pressure in the cooker falls to 1 bar. **08**

OR

5 a) Why Carnot cycle not practicable for steam power plant? **04**

b) With the help of flow diagram with two feed heaters and T-s disarms explain the actual Regenerative Rankine cycle and derive its cycle efficiency (Assuming two feed heaters). **08**

c) A steam power station uses the following cycle: Steam at boiler outlet – 150 bar, 550°C; Reheat at 40 bar to 550°C; Condenser at 0.1 bar. Assuming the ideal processes. Determine: i) The quality of steam at turbine exit, ii) The cycle efficiency, and iii) The steam rate. **08**

UNIT - V

6 a) Discuss the effect of following with respect to Vapour Compression Refrigeration using T-s diagram: i) Sub-cooling, and ii) Superheating. **04**

b) Describe with the help of flow diagram the vapour absorption system of refrigeration cycle and also write expression for COP in terms of temperature. **08**

c) A vapour compression refrigeration plant used R-12 and is to develop 5 tons of refrigeration. The condenser and evaporator temperature are to be 40°C and -10°C respectively. Determine: i) The refrigerant flow rate in kg/s, ii) The volume flow rate handled by the compressor in m^3/s, iii) COP, and iv) The power required to drive the compressor. **08**

OR

7 a) Define the following terms: i) Wet bulb and Dry temperature, ii) Relative humidity, and iii) Specific humidity. **06**

b) Sketch the following process on Psychometric chart: i) Sensible cooling, ii) Heating and Humidification, iii) Adiabatic mixing of two streams. **06**

c) It is required to design an air conditioning plant for an office room with the following conditions: **08**

Outdoor conditions= 14°C DBT and 10°C WBT
Required conditions= 20°C DBT and 60% RH
Amount of air circulation = 0.3 m^3/min/person
Seating capacity of the office=60
The required condition is achieved first by heating and then by adiabatic humidifying. Determine the following: i) Heating capacity of the coil in kW and the surface temperature required, ii) Capacity of the humidifier.

******