Roll No. ..... Total Pages : 3

**002410**

**May 2024**

**B.Tech. (Civil) - IV SEMESTER**

**Mechanical Engineering (ESC-209)**

Time : 3 Hours] [Max. Marks : 75

*Instructions :*

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

## PART–A

**1.** (a) Differentiate between an open and a closed thermodynamic system. (1.5)

(b) What do you mean by intensive and extensive properties? (1.5)

(c) State Zeroth law. (1.5)

(d) What are the limitations of first law of thermodynamics? (1.5)

(e) Give the Kelvin Plank statement of II law of thermodynamics. (1.5)

(f) What will be the value of 10 degree Celsius temperature in Fahrenheit? (1.5)

(g) Define dryness fraction of steam. (1.5)

(h) What is an adiabatic process? (1.5)

(i) Define Latent heat of Vaporization. (1.5)

(j) Define Coefficient of Performance. (1.5)

## PART–B

**2.** (a) Derive the expressions for work transfer for constant pressure for a closed system. (7)

(b) What is thermodynamic equilibrium? (8)

**3.** (a) A stationary mass of gas is compressed without friction from an initial state of 0.3 $m^3$ and 0.105MPa to a final state of 0.15 $m^3$ and 0.105 MPa, the pressure remaining constant during the process. There is a transfer of 37.6 kJ of heat from the gas during the process. How much does the internal energy of the gas change? (7)

(b) Discuss the formation of steam at constant pressure. (8)

**4.** Air at a temperature of 15°C passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 800°C. It then enters a turbine with same velocity of 30 m/s and expands till the temperature falls to 650°C. On leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 500°C. If the air flow rate is 2 kg/s, calculate, (i) Rate of heat transfer to the air in the heat exchanger, (ii) The power



output from the turbine assuming no heat loss, (iii) The velocity at exit from the nozzle, assuming no heat loss.

Take the enthalpy of air $h = C_p t$, where $C_p$ is the specific heat and is equal to 1.005 kJ/kgK and t is the temperature. (15)

**5.** (a) What is a Carnot cycle? What are the four processes constituting the cycle? (7)

(b) In a thermodynamic cycle, the turbine output is 600 kj/kg, the compressor work is 400 kj/kg and the heat supplied is 1000 kj/kg, determine the thermal efficiency of the cycle. (8)

**6.** Draw an diesel cycle on p-V and T-S plot. Also derive its air standard efficiency in terms of compression ratio. (15)

**7.** With a neat sketch explain the working of a Vapour Compression refrigeration cycle. Also find its COP. (15)

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