Registration No: | | | | | | | | | | |

Total Number of Pages : 03 **Course: B.Tech**
Sub Code: RME4C002

4th Semester Regular / Back Examination: 2022-23
SUBJECT: Engineering Thermodynamics
BRANCH(S): MECH, MMEAM
Time : 3 Hour
Max Marks : 100
Q.Code : M268

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions :** **(2 x 10)**

a) What do you mean by a steady flow process? Write down the general energy equation for steady flow process.
b) Write down the entropy balance equation for steady flow processes.
c) What do you mean by 'dead state'?
d) Define the coefficient of (i) Volume expansion, (ii) Isothermal Compressibility
e) What are the four basic components of a steam power plant?
f) Draw the T-s diagram for ideal jet propulsion cycle.
g) How is a reversed Brayton cycle used for refrigeration?
h) Define the volumetric efficiency of a compressor.
i) What do you mean by Optimum pressure ratio of a gas turbine?
j) Represent Rankine cycle on a T-s diagram.

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 × 8)

a) Calculate the change of entropy of a 5 kg of perfect gas when it is heated from 423 K to 473 K under constant volume conditions. Its specific heat varies with temperature as:

$C_v = (0.45 + 0.009\ T)$ kJ/kg K

b) Define the following:
i) Available energy
ii) Second law efficiency

c) Show that for a perfect gas

$$\left[\frac{\partial u}{\partial T}\right]_P = c_P - \alpha P v$$

Where the coefficient of volume expansion α is given by

$$\alpha = \frac{1}{v}\left[\frac{\partial v}{\partial T}\right]_p$$

d) Derive the Maxwell's equations.

e) Why is a Carnot cycle not practicable for a steam power plant?

f) What is the effect of regeneration on Brayton cycle efficiency? Define the effectiveness of regenerator.

g) Describe an absorption refrigeration cycle?

h) Briefly explain about a back pressure turbine.

i) What is an air standard cycle? Why are such cycles conceived?

j) A refrigerating system operates on the reversed Carnot cycle. The higher temperature of the refrigerant in the system is 35^0C and the lower temperature is -15^0C. The capacity is to be 12 tonnes. Neglect all losses. Determine:

i) Coefficient of performance
ii) Heat rejected from the system per hour
iii) Power required.

k) A SI engine, operating in an Otto cycle, has its inlet parameters 323K and 1 bar while it develops a maximum pressure of 25 bar. Determine

i) The air standard efficiency of the cycle
ii) The mean effective pressure

Take,

the bore = 250 mm, stroke = 375 mm, clearance volume = 0.00263 m^3 and the index of compression = 1.4

l) What is the need of staging the compression process?

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 **a)** Give the exergy balance for a closed system **(8)**

b) Calculate the available energy in 40 kg of water at 75^0C with respect to the surroundings at 5^0C , the pressure of water being 1 atm. **(8)**

Q4 **a)** Steam at 20 bar and 360^0C is expanded in a steam turbine to a pressure of 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. **(10)**

i) Assuming ideal processes, find per kg of steam the net work and the cycle efficiency.

ii) If the turbine and the pump have each 80% efficiency, find the percentage reduction in the net work and the cycle efficiency.

b) State the advantages of Regenerative cycle over simple Rankine cycle. **(6)**

Q5 **a)** Derive an expression for the **(6)**

i) Net work output

ii) Thermal efficiency of a diesel cycle.

b) In a gas turbine plant, working on the Brayton cycle with a regenerator of 75% effectiveness, the air at the inlet to the compressor is at 0.1 MPa, 30^0C, the pressure ratio is 6, and the maximum cycle temperature is 900^0C. If the turbine and compressor have each an efficiency of 80%, find the percentage increase in the cycle efficiency due to regeneration. **(10)**

Q6 A two-stage air compressor with perfect intercooling takes in air at 1 bar pressure and 27^0C. The law of compression in both the stages is $pv^{1.3}$ = constant. The compressed air is delivered at 9 bar from HP cylinder to an air receiver. Calculate per kilogram of air, (a) the minimum work done, and (b) the heat rejected to the intercooler. **(16)**

Derive the relation used for minimum work.