Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: Applied Thermodynamics **Semester: IV**
Program: B.Tech Mechanical **Time : 03 hrs.**
Course Code: MECH 2024 **Max. Marks: 100**

Instructions: Make suitable assumptions (if any needed)

SECTION A
(5Qx4M=20Marks)

S. No.	Question	Marks	CO
Q 1	Draw the comparison between the Vapour absorption refrigeration (VAR) and Vapour compression refrigeration	**4**	**CO1**
Q 2	Explain the following terms (a) Stagnation properties (b) "Sonic speed is a thermodynamic property"	**4**	**CO1**
Q 3	Explain the following (a) Wet Bulb Depression (b) Degree of saturation	**4**	**CO1**
Q 4	What is air conditioning? What equipments are used in the air-conditioning system and what physical parameters are required to be controlled by an air-conditioner	**4**	**CO1**
Q 5	What is cogeneration and what is its efficiency? Derive the relations for the efficiency and utilization factor of a cogeneration plant.	**4**	**CO1**

SECTION B
(4Qx10M= 40 Marks)

Q 6 — A Freon-12 vapor compression refrigeration system has a condensing temperature of 40 deg. C and evaporating temperature of 0 deg. C. The refrigeration capacity is 8 Tonnes. The liquid leaving the condenser is saturated liquid and compression is isentropic. Determine (i) The refrigerant flow rate (ii) The power required to run the compressor (iii) The heat rejected in the plant (iv) COP of the system. Take enthalpy at the end of isentropic compression = 220 kJ/kg. The properties of F-12 are detailed in table below. **10** **CO3**

Temp deg. C	**Pressure bar**	**h_f kJ/kg**	**h_g kJ/kg**	**s_f kJ/kg K**	**s_g kJ/kg K**
40	**12.199**	**84.868**	**206.298**	**0.3034**	**0.6792**
0	**3.086**	**36.022**	**187.397**	**0.1418**	**0.6960**

Q 7	In and air standard Diesel cycle, the compression ratio is 16. The compression begins at 0.1 MPa, 40 degree Celsius. The heat added is 2.0 MJ/kg. Find (a) the maximum temperature of the cycle, (b) the work done per kg of air, (c) cycle efficiency, (d) the temperature at the end of isentropic expansion, (e) cut-off ratio, (f) The Max. Pressure of the cycle and (g) The M.e.p of the cycle.	**10**	**CO3**
Q 8	A single stage single acting compressor is used to deliver air at 70 bar from a suction pressure of 1 bar at the rate of 2.3 m^3 /min. measured at the free air condition of 101.325 kPa and 15 deg.C. The temperature at the end of the suction stroke is 32 Deg.C. Calculate the indicated power required if the compression is carried out in two stages with an ideal intermediate pressure and complete intercooling. The index of compression and expansion for both stages is 1.25. Also, calculate the heat rejected per minute to the intercooler and saving in the power over single stage compression. Take C_p=1 for air and C_v=0.278 kJ/kgK. Neglect clearance.	**10**	**CO3**
Q 9	Dry saturated steam at a pressure of 10 bar is expanded isentropically in a nozzle to pressure of 0.7 bar. With the help of Mollier's diagram, find the velocity and dryness fraction of the steam issuing from the nozzle, if the friction is neglected. Also, find the velocity and dryness fraction of the steam if 15% of the heat drop is lost in friction. **OR** An engine working on the Otto cycle is supplied with air at 1 atmospheric pressure, 25 degree Celsius and the compression ratio is 8. Heat supplied is 2550 kJ/kg. Calculate the maximum pressure and temperature of the cycle, the cycle efficiency and the mean effective pressure (for air Cp=1.005, Cv=0.718, and R=0.287 KJ/Kg K)	**10**	**CO4**
SECTION-C (2Qx20M=40 Marks)			
Q 10	(a) Two streams of air 25 deg. Celcius, 50% RH and 25 deg. Celcius, 60% RH are mixed adiabatically to obtain 0.3 kg/s of dry air at 30 deg Celcius. Calculate the amount of air drawn from both the streams and the humidity ratio of the mixed air. (b) Air-water vapour mixture at 0.1 MPa, 30 deg cel, 80% RH has a volume of 50 m3. Calculate the specific humidity, dew point, WBT, mass of dry air and mass of water vapour. If the mixture is cooled at constant pressure at 5 Deg Celcius. Calculate the amount of water vapour condensed.	**20**	**CO4**
Q 11	(a) Explain the following in reference to expansion through the nozzle, also plot it the on h-s axes. 1. Metastable Expansion 2. Degree of undercooling 3. Degree of super saturation 4. Wilson line	**20**	**CO2**

	(b) Show that for the maximum discharge through a nozzle the ration of the throat pressure to inlet pressure is given by $[2/(n+1)]^{n/n-1}$ where n is the index of isentropic expansion through the nozzle. OR (a) Plot the following processes on the Psychrometeric chart and Analyse the state of the air after, a. Cooling and dehumidification b. Heating and dehumidification c. Adiabatic saturation process d. Mixing of Air streams (b) With the help of a neat line and T-s diagram, derive the relation for the following for a multistage vapour compression refrigeration cycle with flash intercooling. a. Refrigeration effect and Total work of compression, and b. Coefficient of performance of the cycle.		