Form A: Paper-setting Blank

Ref. No. Ex/PE/T/221/2018

2[ND] YEAR POWER ENGG. 2[ND] SEMESTER EXAMINATION, 2018

SUBJECT: **Engineering Thermodynamics-II**

Time: Three Hours

Full Marks 100

Different question of the same Part should be answered at one Place.
Use of steam Table, Refrigerant *R134a* and enthalpy table are allowed.
Psychrometric chart will be supplied, if required

Part - A

1	Considering the 1[st] *Tds* equation and 2[nd] *Tds* equation show that $(c_p - c_v) = \dfrac{Tv\beta^2}{K_T}$ where β = volume expansivity and K_T =isothermal compressibility Show that the slope of an isentropic line is greater than that of an isothermal line on p-v diagram	10+6
OR	What is Joule Thomson Coefficient? Write the expression for Joule Thomson coefficient and determine its value for ideal gas. Derive a relation for the internal energy change as a gas that obeys the van der Waals equation of state $(P + \frac{a}{v^2})(v - b) = RT$. Assume that in the range of interest c_V varies according to the relation , where $c_V = c_1 + c_2 T$ and c_1, c_2 are constants.	6+10

Part - B

Answer any two

2 a)	Compare air standard efficiency of Otto, Diesel and dual cycle for same compression ratio and heat rejection with p-v and T-s diagrams.	4
b)	Show an air standard Diesel cycle on p-v and T-s diagram clearly stating the processes. Derive its thermal efficiency in terms of compression ratio and cut-off ratio.	12
c)	An engine operating on Otto cycle having cylinder bore and stroke of 40 cm each. If the clearance volume is 4800 cm^3, compute the air standard efficiency.	4
3	A gas-turbine power plant operating on a Brayton cycle has a pressure ratio of 8. The gas enters the compressor at 0.1 MPa, 27°C. Maximum cycle temperature is 1127°C. Assuming a compressor and turbine efficiency of 85% each, a regenerator of 90% effectiveness is placed at turbine exit. Determine (a) the back work ratio, (b) the gain in thermal efficiency due to regeneration, and (c) the turbine exit temperature.	20
4. a)	State the effect of regeneration on specific output, mean temperature of heat addition with reasons in support of your answer.	4
b)	Mention Merits and demerits of open and closed feed water heaters.	4
c)	A steam power plant operates on an ideal regenerative Rankine cycle. Steam enters the turbine at 6 MPa and 450°C and is condensed in the condenser at 20 kPa. Steam is extracted from the turbine at 0.4 MPa to heat the feed water in an open feed water heater. Water leaves the feed water heater as a saturated liquid. Show the cycle on a *T-s* diagram, and determine (*a*) the network output per kilogram of steam flowing through the boiler and (*b*) the thermal efficiency of the cycle.	12

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5	Consider a steam power plant that operates on a reheat Rankine cycle and has a net power output of 80 MW. Steam enters the high-pressure turbine at 10 MPa and 500°C and the low-pressure turbine at 1 MPa and 500°C. Steam leaves the condenser as a saturated liquid at a pressure of 10 kPa. The isentropic efficiency of the Low pressure turbine is 90 percent. Show the cycle on a *T-s* diagram with respect to saturation lines, and determine (*a*) the quality (or temperature, if superheated) of the steam at the turbine exit, (*b*) the thermal efficiency of the cycle, and (*c*) the mass flow rate of the steam.	20

Part - C

Answer any two

6. a)	A wet cooling tower is to cool 25 kg/s of cooling water from 40 to 30°C at a location where the atmospheric pressure is 96 kPa. Atmospheric air enters the tower at 20°C and 70 percent relative humidity and leaves saturated at 35°C. Neglecting the power input to the fan, determine (*a*) the volume flow rate of air into the cooling tower and (*b*) the mass flow rate of the required makeup water	12
b)	Define relative humidity and humidity ratio	4
7. a)	An ideal gas refrigeration cycle using air as the working fluid is to maintain a refrigerated space at $-23°C$ while rejecting heat to the surrounding medium at 27°C. If the pressure ratio of the compressor is 3, determine (*a*) the maximum and minimum temperatures in the cycle and (*b*) the coefficient of performance.	6
b)	A refrigerator uses refrigerant-134a as the working fluid and operates on an ideal vapor-compression refrigeration cycle between –20°C and 31.25°C (corresponding saturation pressure is 0.8 Mpa). The mass flow rate of the refrigerant is 0.05 kg/s. Show the cycle on a *p-h* diagram with respect to saturation lines. Determine (*a*) the rate of heat removal from the refrigerated space and the power input to the compressor, (*b*) the rate of heat rejection to the environment, and (*c*) the coefficient of performance.	10
8.a)	Show the mechanical component a vapour compression refrigeration system, and show the actual thermodynamic cycle in T-s diagram	4
b)	Throttle valve is not used in gas refrigeration - Justify the statement considering Joule-Kelvin expansion.	4
c)	Air enters a window air conditioner at 0.1 Mpa, 30°C and 70% relative humidity at a rate of 2 m^3/min and it leaves as saturated air at 15°C. The condensate is removed at 15°C. Determine the rate of heat removal and moisture removal from the air	8

Part - D

9 a)	Propylene (C_3H_6) is burned with 50 percent excess air during a combustion process. Assuming complete combustion and a total pressure of 105 kPa, determine (*a*) the air–fuel ratio and (*b*) the temperature at which the water vapor in the products will start condensing.	6+2
b)	Define enthalpy of formation. What is adiabatic flame temperature? When its value will be maximum?	2+1+1
OR	Methane (CH_4) gas enters a steady-flow combustion chamber at 25°C and 1 atm and is burned with 50 percent excess air, which also enters at 25°C and 1 atm,. After combustion, the products exit at 1000 K. Assuming complete combustion, determine the heat transfer per kmol of CH_4	12