Roll No: | | | | | | | | | | | | | |

BTECH
(SEM III) THEORY EXAMINATION 2021-22
THERMODYNAMICS

Time: 3 Hours ***Total Marks: 100***

Notes:

- *Attempt all Sections and Assume any missing data.*
- *Appropriate marks are allotted to each question, answer accordingly.*

SECTION-A	Attempt **All** of the following Questions in brief	Marks**(10X2=20)**	**CO**
Q1(a)	Differentiate microscopic and macroscopic point of view.		1
Q1(b)	Define the quasi static process?		1
Q1(c)	Define the second law efficiency and why PMM-II is not possible.		2
Q1(d)	Distinguish between high grade energy and low-grade energy?		2
Q1(e)	Explain the Joule-Thompson coefficient and Inversion curve?		3
Q1(f)	Discuss the triple point and critical point.		4
Q1(g)	Define the refrigeration effect and how it can be improved?		5
Q1(h)	Explain the dryness fraction and how it can be improved?		4
Q1(i)	How the C.O.P of the vapor compression cycle can be improved?		5
Q1(j)	Differentiate between available and unavailable energy?		3

SECTION-B	Attempt **ANY THREE** of the following Questions	Marks**(3X10=30)**	**CO**
Q2(a)	A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it. (i) Find the velocity at exists from the nozzle. (ii) If the inlet area is 0.1 m2 and the specific volume at inlet is 0.187 m3/kg, find the mass flow rate.		1
Q2(b)	A heat pump working on the Carnot cycle takes in heat from a reservoir at 5°C and delivers heat to a reservoir at 60°C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir at 840°C and rejects heat to a reservoir at 60°C. The reversible heat engine also drives a machine that absorbs 30 kW. If the heat pump extracts 17 kJ/s from the 5°C reservoir, determine (i) The rate of heat supply from the 840°C source (ii) The rate of heat rejection to the 60°C sink.		2
Q2(c)	Write down the first and second T-dS equations and derive the expression for the difference in heat capacities, Cp and Cv .		3
Q2(d)	Define in pure substance by suitable phase change diagram the term (i) Triple Point (ii) Critical Point (iii) Saturation states (iv) Sub cooled state (v) Superheated vapour state.		4
Q2(e)	The atmospheric air pressure 1 bar and temperature -5^0 C is drawn in the cylinder of the compressor of Bell Coleman refrigerating machine. It is compressed isentropically to a pressure of 5 bar. In the cooler the compressed air is cooled to 15^0 C, pressure remaining the same. It is then expanded to a pressure of 1 bar in an expansion cylinder from where it is passed to the cold chamber. Calculate (i)The work done per kg of air (ii) C.O.P of the plant For air assume law for expansion $PV^{1.2}$ =Constant: law for compression is $PV^{1.4}$ =Constant specific heat of the air at constant pressure is 1 KJ/Kg-K		5

SECTION-C	Attempt **ANY ONE** following Question	Marks **(1X10=10)**	**CO**
Q3(a)	The internal energy of a certain substance is given by the following equation u=3.56 pv + 84, where u is given in KJ/Kg , P is in KPa and v is in m^3/kg A system composed of 3 kg of this substance expands from an initial pressure of 500 KPa and a volume of 0.22 m^3 to a final pressure 100 KPa in a process in which pressure and volume are related by $PV^{1.2}$ =Constant		1

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	i. If the expansion is quasi static find Q,ΔU and W for the process ii. In another process the same expands according to the same pressure –volume relationship as in part (i) and from the same initial state to the same final state as in part (i), but the heat transfer in this case is 30 KJ. Find the work transfer for this process. iii. Explain the difference in work transfer in parts (i) and (ii)	
Q3(b)	For a sample of air having 22^0 DBT, relative humidity 30 % at barometric pressure of 760 mm of Hg calculate (i) Vapour pressure (ii) Humidity ratio. (iii) Vapour density and (iv) Enthalpy Verify yours results by psychometric chart.	4

SECTION-C	Attempt **ANY ONE** following Question	Marks **(1X10=10)**	**CO**
Q4(a)	Steam at 20 bar 360^0 C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to a saturated liquid water. The pump feeds back the water in to the boiler (i) Assuming ideal processes, find the per kg of steams of the network and the cycle efficiency (ii) If the turbine and the pump have each 80% efficiency ,find the percentage reduction in the network and cycle efficiency.		4
Q4(b)	Prove that : $C_P - C_v = -T(\partial V/\partial T)^2_p (\partial P/\partial V)_T$		3

SECTION-C	Attempt **ANY ONE** following Question	Marks **(1X10=10)**	**CO**
Q5(a)	State the Clapeyron equation and discuss its importance during phase change of pure substance. Derive the equation for Clausius-Clapeyron equation for evaporation of liquids.		3
Q5(b)	A vapour compression refrigeration system uses R-12 refrigerant, and the liquid evaporates in the evaporator at – 15°C. The Temperature of this refrigerant at the delivery from the compressor is 15 °C when the vapour is condensed at 10°C. Find the coefficient of performance (i) If there is no under cooling and (ii) the liquid is cooled by 5°C before expansion by throttling.		5

SECTION-C	Attempt **ANY ONE** following Question	Marks **(1X10=10)**	**CO**
Q6(a)	Draw a neat diagram of lithium bromide water absorption system and explain its working. List the major field of applications of this system.		5
Q6(b)	(i) One kg of water at 273 K is brought in to contact with a heat reservoir at 373 K When the water has reached 373 K, find the entropy change of the water of the heat reservoir and of the universe (ii) If the water is heated from 273 K to 373 K by firs bringing It in contact with a reservoir at 323 K and then with a reservoir at 373 K, what will the opy change of the universe be? (iii) Explain how water might be heated from 273 to 373 K with almost no change in the opy of the universe.		2

SECTION-C	Attempt **ANY ONE** following Question	Marks **(1X10=10)**	**CO**
Q7(a)	A gas undergoes a thermodynamic cycle consisting of the following (i) Process 1-2 is isochoric heat addition of 325.235 KJ/kg (ii) Process 2-3 adiabatic expansion to its original pressure with loss of 70 KJ/kg in internal energy (iii) Process 3-1 isobaric compression to its original volume with heat rejection of 200 KJ/kg Prepare a balance sheet of energy quantities and find the overall changes during the cycle		1
Q7(b)	Show that the Kelvin–Planck and the Clausius statement of the second law of thermodynamics are equivalent.		2