Subject Code………………… **ROLL NO………………………**

SEMESTER EXAMINATION 2022-23

1st year M.Tech. Thermal Engineering

Advanced Thermodynamics (TET-301)

Duration: 3 hrs **Max. Marks: 100**

Note: - Attempt all questions. All question carry equal marks. In case any ambiguity or missing data, the same may be assumed and state the assumption made in the answer.

Q.1.	**Answer any four parts of the following.**	**5×4=20**
	a) What do you understand by useful work? Derive the expression for useful work for a closed system and a steady flow system which interact with the surroundings. b) Derive Maxwell equations. c) How are the maximum temperature and maximum pressure in the Rankine cycle fixed? d) What is binary vapor cycle? e) Why second law is called the directional law of nature? f) What is meant by availability?	
Q.2.	**Answer any four parts of the following.**	**5×4=20**
	a) Show that the internal energy and enthalpy of an ideal gas are function of temperature only. b) State and explain Gouy Stodola theorem. c) Derive an expression for maximum work obtainable from two finite bodies at temperature T_1 and T_2. d) What do you understand by entropy transfer? Why is entropy transfer associated with heat transfer and not with work transfer? e) Discuss the increase of entropy principle and decrease of exergy principle. f) Explain how thermodynamic properties are evaluated from an equation of state?	
Q.3.	**Attempt any two parts of the following.**	**10×2=20**
	a) Two kg of air at 500 KPa, 80^0C expand adiabatically in aclosed system until its volume id doubled and its temperature becomes equal to that of the surroundings which is at 100 KPa, 5^0C. For this process, determine (a) The maximum work, (b) The change in availability, (c) the irreversibility. For air take C_v = 0.718 KJ/Kg K , u = C_vT where C_v is constant , and pV = MRT where p is pressure in KPa, V volume in m^3, m is mass in Kg, R a constant equal to 0.287 KJ/kg K, and T temperature in K.	

	b) Derive an expression for exergy of a steady flow system. c) A system has a heat capacity at constant volume $$C_V = A\,T^2$$ Where A= 0.042J/K^3 The system is originally at 200 K, and a thermal reservoir at 100 K is available. What is the maximum amount of work that can be recovered as the system is cooled down to the temperature of reservoir.	
Q.4.	**Attempt any two parts of the following.**	**10×2=20**
	a) One kg of ice at -5^{0}C is exposed to the atmosphere which is at 20^{0}C. The ice melts and comes into thermal equilibrium with the atmosphere. (a) Determine the entropy increase of the universe. (b) What is the minimum amount of work necessary to convert the water back into ice at -5^{0}C? C_p of ice is 2.093 KJ/Kg K and the latent heat of fusion of ice is 333.3 KJ/Kg. b) Derive the expression for irreversibility or exergy loss in a process executed by a) closed system, b) a steady flow system in a given environment. c) Air expands through a turbine from 500 KPa, 520^{0}C to 100 KPa, 300^{0}C. During expansion 10 KJ/Kg of heat is lost to the surroundings which is at 98 KPa, 20^{0}C. Neglecting the K.E and P.E. Changes, Determine per Kg of air (a) The decrease in availability, (b) The maximum work and (c) The irreversibility. For air take C_p = 1.005 KJ/Kg K, h = C_p T where C_p is constant, and takes the p, V, T relation as pV = mRT.	
Q.5.	**Attempt any two parts of the following.**	**10×2=20**
	a) Determine the maximum work obtained by using one finite body at temperature T and a thermal energy reservoir at temperature T_0, $T>T_0$. b) Two identical bodies of constant heat capacity are at the same initial temperature Ti. A refrigerator operates between these two bodies until one body is cooled to temperature T_2. If the bodies remain at constant pressure and undergo no change of phase, show that the minimum amount of work needed to this is $$W(min) = C_p\left(\frac{{T_i}^2}{T_2} + T_2 - 2T_i\right)$$ c) A fluid is confined in a cylinder by a spring loaded, friction less piston so that the pressure in the fluid is a linear function of the volume $$p = a + bv.$$ The internal energy of the fluid is given by the following equation:	

	$$u = 34 + 3.15\,pv$$ Where U is in KJ, P in KPa, and V in cubic metre. If the fluid changes from an initial state of 170 KPa, 0.03 m^3 to a final state of 400 KPa, 0.06 m^3, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer.	