Ref. No.: Ex/EE/ES/B/ME/T/216/2023(S)

B.E. ELECTRICAL ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM 2023

ENGINEERING THERMODYNAMICS & HEAT POWER

Time: Three hours **Full Marks 100**

All parts of the same question must be answered together. Assume any unfurnished data suitably
Use of Thermodynamic Tables and Charts permitted

Group I

Answer any one question

1 (a)	What is the difference between close system and open system?	2
(b)	What is a flow process? What is its importance in engineering?	2
(c)	Give the examples of intensive and extensive properties.	2
(d)	An ideal gas at a given state expands to a fixed final volume first at constant pressure and then at constant temperature. For which case is the work done greater?	2
(e)	What is the difference between heat pump and refrigerator?	2
(f)	Four kg of water at 100°C fills a closed container having a volume of 1 m^3. If the water at this state is a vapor, determine the pressure, in bar. If the water is a two-phase liquid–vapor mixture, determine the quality.	10
2 (a)	What is difference between state function and path function?	3
(b)	Explain the concept of thermodynamic work.	3
(c)	Define sensible heat and latent heat with reference to molecular activities.	4
(d)	A slow chemical reaction takes place in a fluid at a constant pressure of 0.1 MPa. The fluid is surrounded by a perfect heat insulator during reaction, which begins at the state 1 and ends at the state 2. The insulation is then removed and 105 kJ of heat flows to surroundings as the fluid goes to the state 3. The following data are observed for fluid at states 1, 2 and 3 respectively: For the fluid, calculate E_2 and E_3, if $E_1 = 0$.	10

State	V(m^3)	T(°c)
1	0.003	20
2	0.3	370
3	0.06	20

[Turn over

	Group II **Answer any three questions**	
3 (a)	What is the difference between the critical point and the triple point?	2
(b)	What is entropy generation? Explain.	5
(c)	Air initially at 60 kPa pressure, 800 K temperature and 0.1 m^3 volume is compressed isothermally until the volume is halved, and subsequently the air is cooled at constant pressure till the volume is halved again. Sketch the process on a p–V plane and determine(a) total work interaction, and(b) total heat interaction. Assume ideal-gas behaviour for air and take C_p = 1.005 kJ/kg-K.	13
4. (a)	Prove that the Kelvin Planck and Clausius's statements of the second law of thermodynamics are equivalent to each other.	10
(b)	A cyclic heat engine operates between a source temperature of 80°C and a sink temperature of 30°C. What is the least rate of heat rejection per kW net output of the engine?	10
5. (a)	State and proof Clausius inequality.	10
(b)	A heat engine having a working substance of mass m and specific heat C_p works between a source at a temperature T_1 and a sink at a temperature T_2. Prove that the maximum obtainable work from such an engine is given by $W_{max}=mC_P\{\sqrt{T_1}-\sqrt{T_2}\}^2$	10
6. (a)	Explain the phase transformation of water from freezing state to superheated state.	10
(b)	Calculate volume, density, enthalpy and entropy of 2 kg of steam at 80^0C and having a dryness fraction of 0.85.	10
	Group III **Answer any one question**	
7 (a)	Why is the Carnot cycle not a realistic model for steam power plants?	5
(b)	Why is excessive moisture in steam undesirable in steam turbines? What is the highest moisture content allowed?	5
(c)	A simple ideal Rankine cycle with water as the working fluid operates between the pressure limits of 3 MPa in the boiler and 30 kPa in the condenser. If the quality at the exit of the turbine cannot be less than 85 percent, what is the maximum thermal	10

	efficiency this cycle can have?	
8 (a)	What are the air-standard assumptions?	5
(b)	Define the following terms related to reciprocating engines: stroke, bore, top dead center, and clearance volume.	5
(c)	Derive an expression for thermal efficiency of diesel cycle	10