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Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF MECHANICAL ENGINEERING

CONTINUOUS ASSESSMENT TEST –II

SLOT: D2+TD2

FALL SEMESTER 2022-2023

Programme Name & Branch : B.Tech (BMA,BME,BMM)
Course Code :BMEE203L
Course Name :Engineering Thermodynamics
Faculty Name(s) :Dr. Nataraj G, Dr. Anuj Kumar, Dr. Somasundharam S, Dr. Mohamed Ibrahim M, Dr. Anoop Kumar
Class Number(s) :VL2022230100602, VL2022230100604, VL2022230100603, VL2022230100596, VL2022230100599
Duration:90min. **Max. Marks:50**

General instruction(s):

1. ***Assume suitable data, if required,***
2. ***Steam Tables and Mollier chart are permitted***

Answer ALL the Questions

Q. No	Question	Marks
1.	a) A steam power plant receives heat from a furnace at a rate of 270 GJ/h. Heat losses to the surrounding air from the steam as it passes through the pipes and other components are estimated to be about 3% of heat received. If the waste heat is transferred to the cooling water at a rate of 190 GJ/h, determine (a) net power output and (b) the thermal efficiency of this power plant.	5
	b) Determine the COP of a refrigerator that removes heat from the food compartment at a rate of 5040 kJ/h for each kW of power it consumes. Also, determine the rate of heat rejection to the outside air.	5
2.	A Carnot heat engine receives heat from a reservoir at 800°C at a rate of 13.33 kJ/s and rejects the waste heat to the ambient air at 30°C. The entire work output of the heat engine is used to drive a refrigerator that removes heat from the refrigerated space at –2°C and transfers it to the same ambient air at 30°C. Determine (a) the maximum rate of heat removal from the refrigerated space and (b) the total rate of heat rejection to the ambient air.	10
3.	A piston–cylinder device contains 0.75 kg of air at 140 kPa and 37°C. The gas is now compressed slowly in a polytropic process during which $PV^{1.3}$ = constant. The process ends when the volume is reduced by one-half. Determine the entropy change of air during this process. Take Cp, Cv and R for air 1.005kJ/kg-k, 0.718 kJ/kg-K and 0.287 KJ/kg-Krespectively.	10
4.	Consider a 210-MW steam power plant that operates on a simple ideal Rankine cycle. Steam	10

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	enters the turbine at 15 MPa and 500°C and is cooled in the condenser at a pressure of 74kPa. Show the cycle on a T-s diagram with respect to saturation lines, and determine (a) the quality of the steam at the turbine exit, (b) the thermal efficiency of the cycle. Take isentropic efficiency of turbine 85%. Neglect the pump work.	
5	An ideal reheat Rankine cycle with water as the working fluid operates the inlet of the high-pressure turbine at 8000 kPa and 450°C, the inlet of the low-pressure turbine at 500 kPa and 500°C, and the condenser at 10 kPa. Determine the mass flow rate through the boiler needed for this system to produce a net 5000 kW of power and the thermal efficiency of the cycle	10

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Vellore - 632014, Tamil Nadu, India
SCHOOL OF MECHANICAL ENGINEERING
FALL SEMESTER 2022-2023

SLOT: D1+TD1

CONTINUOUS ASSESSMENT TEST – II

Programme Name & Branch	: B.Tech- Automotive, Mechanical, Manufacturing Engineering
Course Code	: BMEE2031.
Course Name	: Engineering Thermodynamics
Class Number(s)	: VL2022230100583, VL2022230100582, VL2022230100580 VL2022230100593, VL2022230100584
Faculty Members	: Dr. Porpatham E, Dr. Thundil Karuppa Raj R, Dr. Rajesh Kanna, Dr. Immanuel Selwyn Raj A, Dr. Praveen Kumar G
Date of Examination	: 13- 10-2022
Duration	: 90 minutes Max. Marks: 5 x 10=50

General instruction(s): 1. ***Assume suitable data, if required,***
2. Steam Tables and Mollier chart are permitted

Answer ALL the Questions

Q. No	Question	Marks
1	a) A 500-MW steam power plant, which is cooled by a nearby river, has a thermal efficiency of 50 percent. Determine the rate of heat transfer to the river water in kW. Will the actual heat transfer rate be higher or lower than this value? Why?	5
	b) An air conditioner removes heat steadily from a house at a rate of 650 kJ/min while drawing electric power at a rate of 5 kW. Determine (i) the COP of this air conditioner and (ii) the rate of heat transfer to the outside air.	5
2	A reversible heat engine operates between two reservoirs at temperatures 500°C and 30°C. The engine drives a reversible refrigerator which operates between reservoirs at 30°C and -10°C. The transfer to the heat engine is 1000 kJ. The entire work produced by the heat engine is used to drive the refrigerator. Calculate the heat transfer to the refrigerant and net heat transfer to the reservoir at 30°C.	10
3	a) A completely reversible heat pump produces heat at a rate of 400 kW to warm a house maintained at 24°C. The exterior air, which is at 7°C, serves as the source. Calculate the rate of entropy change of the two reservoirs and determine if this heat pump satisfies the second law according to the increase of entropy principle.	5
	b) A heat engine that receives heat from a source at 1000°C and rejects waste heat to a river at 20°C has a thermal efficiency of 60 percent. Determine the second-law efficiency of this power plant. If 800 kJ is supplied to this engine calculate the exergy.	

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4	A simple Rankine cycle which uses water as the working fluid operates its condenser at 40°C and its boiler at 400°C. Calculate the work produced by the turbine, the heat supplied in the boiler, and the thermal efficiency of this cycle if the boiler pressure is 40 bar. Assume the turbine is having 80% efficiency and pump is working with 90% efficiency. Use steam table for properties.	10
5	An ideal reheat Rankine cycle using water as the working fluid which enters condenser at 1 bar with entropy as 7.3 kJ/kg K. The steam entered both low pressure and high-pressure turbine at 450°C. The steam leaves at dry condition from high pressure turbine. If the mass flow rate through the cycle is 1.74 kg/s, determine the power used by pumps, the power produced in the cycle, the rate of heat transfer in the reheater, and the thermal efficiency of this system. Use steam table and Mollier chart.	10