Reg. No. | | | | | | | | | | | | |

B.E./ B. TECH DEGREE EXAMINATIONS, MAY 2023

First Semester

MR22201 – THERMAL ENGINEERING FOR MARINE ENGINEERS

(Use of Steam Tables and Mollier Diagram are permitted)

(Regulation 2022)

TIME: 3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Students should be able to understand the first law of thermodynamics along with engineering applications	4
CO 2	Students should be able to recognize heat engines, heat pumps and refrigerators and applications of the second law of thermodynamics	3
CO 3	Students should be able to comprehend the steam formation process, properties of steam and its application to Rankine cycle	3
CO 4	Students should be able to analyze various air standard cycles and their application	3
CO 5	Students should be able to know the vapour compression refrigeration cycle and its analysis	3

PART- A(20x2=40Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Define the term specific property with an example.	1	2
2.	State the Zeroth Law of Thermodynamics.	1	1
3.	What do you understand by an Isobaric process?	1	2
4.	How do you determine the displacement work?	1	2
5.	Differentiate between a reversible and irreversible process.	2	2
6.	State the limitations of First law of Thermodynamics.	2	1
7.	What is meant by Thermal Energy reservoir? Give an example.	2	2
8.	What do you infer from the Clausius statement of second law of Thermodynamics?	2	2
9.	How do you calculate the term dryness fraction?	3	2
10.	Write the Gibbs phase rule and expand the terms.	3	2
11.	What happens to saturation temperature and freezing point of a liquid with an increase in its saturation pressure?	3	2
12.	What do you understand by the term “specific steam consumption”?	3	2
13.	What is meant by Cut off ratio in the diesel cycle?	4	2
14.	What is the significance of explosion ratio in the dual cycle?	4	2

15.	Write the formula to determine efficiency of the Otto cycle with compression ratio.	4	2
16.	What are the four processes that form the Carnot cycle?	4	1
17.	What is the purpose of “Thermostatic expansion valve” in a Vapour compression refrigeration system?	5	2
18.	What do you understand by the term “Coefficient of Performance”?	5	2
19.	What are the desirable properties of Marine refrigerants?	5	2
20.	How does Marine Refrigerants destroy the Ozone layer?	5	2

PART- B (5x 10=50Marks)

		Marks	CO	RBT LEVEL
21. (a)	Sketch a P-V diagram showing the following processes in a cycle ***Process 1-2***: isobaric work output of 10.5 kJ from an initial volume of 0.028 m^3 and pressure 1.4 bar, ***Process 2-3***: isothermal compression, and ***Process 3-1***: isochoric heat transfer to its original volume of 0.028 m^3 and pressure 1.4 bar. Calculate (a) the maximum volume in the cycle, in m^3, (b) the isothermal work, in kJ, (c) the network, in kJ, and (d) the heat transfer during isobaric expansion, in kJ.	(10)	1	3
	(OR)			
(b)	Derive an expression for mass balance and energy balance in a simple steady flow process.	(10)	1	3
22. (a)	A Carnot heat engine receives 500 kJ of heat per cycle from a high-temperature heat reservoir at 652ºC and rejects heat to a low-temperature heat reservoir at 30ºC. Determine: (a) The thermal efficiency of this Carnot engine (b) The amount of heat rejected to the low-temperature heat reservoir.	(10)	2	3
	(OR)			
(b)	Two reversible heat engines A & B are arranged in series. Engine A rejecting heat directly to B. Engine A receives 200 kJ of heat at a temperature of 421°C from a hot source while engine B is in communication with a cold sink at a	(10)	2	3

temperature of 4.4°C. If the work output of engine A is twice that of the engine B, Find (i). Intermediate temperature between engines A & B and (ii). Efficiency of the engines A and B.

23. (a)	**(i)**	An ideal gas is contained in a closed assembly with an initial pressure and temperature of 220 kpa and 70^0 C respectively. If volume of the system is increased to 1.5 times of the initial volume and the temperature drops to 15^0 C, determine the final pressure of the gas.	**(5)**	**3**	**3**
	(ii)	A closed assembly contains 2 kg of air at an initial pressure and temperature of 140 kpa and 210^0 C respectively. If volume of the system is doubled and temperature drops to 37^0 C, determine the final pressure of the air. Air can be modeled as an ideal gas.	**(5)**	**3**	**3**
		(OR)			
	(b)	Two kg of steam at a pressure of 8 bar occupies a volume of 0.3 m^3. If the air expands to a volume of 1.5 m^3 according to the law $PV^{1.35} = C$. Calculate the work done and change in change in entropy during the process.	**(10)**	**3**	**3**
24. (a)		Evaluate an expression for efficiency, work done and mean effective pressure of Otto cycle with usual notations.	**(10)**	**4**	**5**
		(OR)			
	(b)	An air-standard Diesel cycle has a compression ratio of 18 and a cut-off ratio of 2.5. The state at the beginning of compression is fixed by P = 0.9 bar and T = 300 K. Evaluate the following: i) The thermal efficiency of the cycle, ii) The maximum pressure, $P_{max,}$ and iii) The mean effective pressure.	**(10)**	**4**	**5**
25. (a)		Sketch and describe the working of Vapour compression refrigeration system and also Mention its advantages and disadvantages.	**(10)**	**5**	**3**
		(OR)			

	(b) **(i)**	The temperature in a domestic refrigerator is to be maintained at - 10°C. Ambient air temperature is 30°C. If the heat leaving the refrigerator is 3 kW, determine the least power necessary to pump out this heat.	**(7)**	**5**	**3**
	(ii)	Determine the CoP of a heat pump if the rate of heat rejected is 360 kJ/min and power supplied is 2 kW.	**(3)**	**5**	**3**

PART- C (1x 10=10Marks)

(Q.No.26 is compulsory)

		Marks	**CO**	**RBT LEVEL**
26.	Analyze the behavior of steady flow energy equation when it flows through the (i) Nozzle and diffuser (ii) Turbine and compressor	**(10)**	**1**	**4**

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