BT MRE-IV(R/S)-06-24-3240 Reg. No. | | | | | | | | |

C

B.Tech. Degree IV Semester Regular/Supplementary Examination in Marine Engineering June 2024

19-208-0402 THERMAL ENGINEERING AND HEAT TRANSFER

(2019 Scheme)

Time: 3 Hours Maximum Marks: 60

Course Outcome

On successful completion of the course, the students will be able to:

CO1: Understand combustion of fuel and gas turbine plants.
CO2: Calculate the work requirement for a given compression ratio.
CO3: Get an insight on conduction and apply it for optimizing the thickness of insulation.
CO4: Solve convective heat transfer problems and understand radiation heat transfer.
CO5: Attain information of parallel and counter flow heat exchangers and their design aspects.

Bloom's Taxonomy Levels (BL): L1 – Remember, L2 – Understand, L3 – Apply, L4 –Analyze, L5 – Evaluate, L6 – Create

PI – Programme Indicators

(Answer *ALL* questions) $(5 \times 15 = 75)$

			Marks	BL	CO	PI
I.	(a)	Explain the working of Junker's gas calorimeter with help of a neat diagram.	10	L2	1	1.4.1
	(b)	Differentiate between higher Calorific value and lower Calorific value of fuel.	5	L2	1	1.4.1
		OR				
II.	(a)	Explain any two methods to improve the thermal efficiency and work ratio of gas turbine plants.	10	L2	1	1.4.1
	(b)	With the help of a block diagram, explain the working of the C-B-T-H cycle.	5	L2	1	1.4.1
III.	(a)	Prove that for minimum work of compression, the intermediate pressure is the geometric mean of suction and discharge pressures for a two-stage compressor.	10	L3	2	1.4.1
	(b)	Explain the working of the Roots blower with the help of a neat sketch.	5	L2	2	1.4.1
		OR				
IV.	(a)	A single-acting two-stage compressor with complete intercooling delivers 10.5 kg/min of air at 16 bar. The suction occurs at 1 bar and 27°C. The compression and expansion processes are reversible with polytropic index as 1.3. The compressor runs at 440 r.p.m. Calculate: (i) The power required to drive the compressor (ii) The isothermal efficiency (iii) The free air delivery (iv) The heat transferred in intercooler.	10	L3	2	1.4.1
	(b)	Briefly explain the effect of clearance on volumetric efficiency.	5	L2	2	1.4.1

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			Marks	BL	CO	PI
V.	(a)	Derive the differential form of equation which establishes the relationship between the time and space variation of temperature at any point of solid through which heat flow by conduction takes place.	8	L3	3	3.1.1
	(b)	Hot air at a temperature of 65°C is flowing through a steel pipe of 120 mm diameter. The pipe is covered with two layers of different insulating materials of thickness 60 mm and 40 mm, and their corresponding thermal conductivities are 0.24 W/m°C and 0.4 W/m°C. The inside and outside heat transfer coefficients are 60 W/m^2°C and 12 W/m^2°C respectively. The atmosphere is at 20°C. Find the rate of heat loss from 60 m length of pipe.	7	L3	3	3.1.1
		OR				
VI.	(a)	Derive the heat conduction equation for a hollow sphere without heat generation. Also comment on the electrical analogy of the derived equation.	8	L3	3	3.2.1
	(b)	An approximately spherical-shaped orange (k = 0.23 W/m°C), 90 mm in diameter, undergoes a riping process and generates 5100 W/m^3 of energy. If the external surface of the orange is at 8°C, determine: (i) Temperature at the center of the orange (ii) Heat flow from the outer surface of the orange.	7	L3	3	3.2.1
VII.		Air at 20°C and at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. If the plate is 500 mm wide and at 60°C, calculate the following quantities at x = 400 mm (i) Boundary layer thickness (ii) Local friction coefficient (iii) Average friction coefficient (iv) Shearing stress due to friction (v) Thickness of the boundary layer (vi) Local convective heat transfer coefficient (vii) Average convective heat transfer coefficient (viii) Rate of heat transfer by convection (ix) Total drag force on the plate (x) Total mass flow rate through the boundary.	15	L3	4	1.4.1
		OR				
VIII.	(a)	Differentiate between black body, opaque body, white body and grey body based on radiant properties.	5	L1	4	1.4.1
	(b)	Explain the difference between Nusselt number and Biot number. Write their physical significance.	5	L1	4	1.4.1
	(c)	Briefly explain the boundary layer concept for flow over flat plates. What is 'no slip' condition?	5	L2	4	1.4.1
IX.	(a)	Differentiate between regenerator and recuperator.	4	L1	5	1.4.1
	(b)	Why we should always use the LMTD when determining the rate of heat transfer in a heat exchanger?	3	L1	5	1.4.1
	(c)	A counter flow double pipe heat exchanger using superheated steam is used to heat water at the rate of 10,500 kg/hr. The steam enters the heat exchanger at 180°C and leaves at 130°C. The inlet and exit temperatures of water are 30°C and 80°C respectively. If overall heat transfer coefficient from steam to water is 814 W/m^2 °C, calculate the heat transfer area. What would be the increase in area if the fluid flows were parallel?	8	L3	5	1.4.1
		OR				
X.	(a)	Derive LMTD equation for counter flow heat exchanger.	10	L3	5	4.1.3
	(b)	Counter-flow heat exchangers can transfer more heat than parallel heat exchangers. Comment your views on this statement.	5	L2	5	4.1.3