

# CBCS SCHEME

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17MR45

## Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020 Marine Heat Engine and Air Conditioning

Time: 3 hrs.

Max. Marks: 100

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

### Module-1

- Define the following with respect to reciprocating compressor:  
(i) Isothermal Efficiency (ii) Adiabatic efficiency  
(iii) Mechanical Efficiency (iv) Overall Efficiency (08 Marks)
  - Derive an expression for volumetric efficiency of single stage compressor. (06 Marks)
  - An air compressor takes in air at 1 bar and 20°C and compresses the same according to the law  $Pv^{1.2} = \text{Constant}$ . It is then delivered to a receiver at a constant pressure of 10 bar. If the R for air is 0.287 kJ/kg K, determine (i) Temperature at the end of compression (ii) Work done (iii) Heat transfer during compression per kg of air. (06 Marks)

OR

- Show that, for minimum work, the intermediate pressure of multistage compressor is the geometric mean of the suction and discharge pressure. (10 Marks)
  - In a 2-stage air compressor, the work output is found to be 350 kJ/kg of air. It is used to compress 1 kg of free air from 1 bar pressure and 32°C initial temperature. The value of  $\eta = 1.3$  and  $R = 0.287$  kJ/kg K. Find (i) Intermediate pressure (ii) Temperature of air after compression in first stage (iii) Rate of heat rejection in compressor. (10 Marks)

### Module-2

- List the desirable properties of a refrigerant used in marine refrigeration system. (10 Marks)
  - A Carnot refrigerator requires 1.3 kW per tonne of refrigeration to maintain a region at low temperature of -38°C. Determine  
(i) COP of Carnot refrigerator  
(ii) Higher temperature of the cycle  
(iii) The heat delivered and COP when this device is used as heat pump. (10 Marks)

OR

- What are the refrigerants used in Marine practice and given their ratings. (08 Marks)
  - 28 tonnes of ice from and at 0°C is produced per day in an ammonia refrigerator. The temperature range in the compressor is from 25°C to -15°C. The vapour is dry and saturated at the end of compression and an expansion valve is used. Assuming a coefficient of performance of 62% of the theoretical, calculate the power required to drive the compressor.

### Properties of Ammonia

Temp (°C)	Enthalpy (kJ/kg)		Entropy (kJ/kg K)	
	Liquid	Vapour	Liquid	Vapour
25	100.04	1319.22	0.3473	4.4852
-15	-54.56	1304.99	-2.1338	5.0585

(12 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.



**Module-3**

- 5 a. Draw the neat sketch of Marine refrigeration plant and list the components of plant. (12 Marks)  
 b. Write a note on maintenance of refrigeration plant used in marine practice. (08 Marks)

OR

- 6 a. Sketch a Thermostatic Expansion Control Valve (TEV) and briefly explain its construction and operation. (08 Marks)  
 b. With neat sketch explain the following : (12 Marks)  
 (i) Refrigerant charging  
 (ii) Oil separator in refrigeration plant

**Module-4**

- 7 a. Draw neat sketch of marine air conditioning plant and explain main components of same. (10 Marks)  
 b. With neat sketch explain the air circulation system. (10 Marks)

OR

- 8 a. Explain the control of humidity in an air conditioning system on board ship. (06 Marks)  
 b. Write a note on trouble shooting and maintenance of air condition system. (06 Marks)  
 c. A room measure  $5\text{m} \times 5\text{m} \times 3\text{m}$ . It contains atmospheric air at 100 kPa. DBT =  $30^\circ\text{C}$  and relative humidity = 30%. Find the mass of dry air and the mass of associated water vapour in the room. Solve the problem without the use of psychrometric chart and using the properties of water vapour from the steam tables. Take  $P_{vs} = 0.042415$  bar at  $30^\circ\text{C}$ . (08 Marks)

**Module-5**

- 9 a. Derive an expression for LMTD of parallel flow heat exchanger. Also state the assumptions made. (10 Marks)  
 b. With neat sketch explain shipside and deck insulation. (10 Marks)

OR

- 10 a. Classify the Heat Exchanger based on design and application. (06 Marks)  
 b. With neat sketch explain shell and tube type heat exchanger. (06 Marks)  
 c. A counter flow heat exchanger is used to cool 2200 kg/hr of oil ( $C_{Po} = 2.5$  kJ/kg K) from  $100^\circ\text{C}$  to  $35^\circ\text{C}$  by the use of water entering at  $17^\circ\text{C}$ . If the overall heat transfer coefficient is expected to be  $1.5$  kW/m<sup>2</sup>K, make calculation for the water flow rate, surface area required and effectiveness of the heat exchanger. Presume that the exit temperature of water is not to exceed  $85^\circ\text{C}$ . (08 Marks)

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