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***B.Tech. Degree III Semester Supplementary Examination in  
Marine Engineering December 2016***

**MRE 303 THERMODYNAMICS AND HEAT TRANSFER  
(2013 Scheme)**

Time : 3 Hours

Maximum Marks : 100

(5 × 20 = 100)

- I. (a) State and explain Carnot's theorem. (5)
- (b) One Kg of ice at  $-5^{\circ}\text{C}$  is exposed to the atmosphere which is at  $20^{\circ}\text{C}$ . The ice melts and comes into the thermal equilibrium with the atmosphere. (15)
- (i) Determine the entropy increase of the universe.
- (ii) What is the minimum amount of work necessary to convert the water back into ice at  $-5^{\circ}\text{C}$  ?

OR

- II. (a) Write the combustion equation for complete combustion of Carbon and incomplete combustion of Carbon. (6)
- (b) Differentiate theoretical and excess air. (4)
- (c) A coal sample gave following analysis by weight, Carbon 85 %, Hydrogen 6%, Oxygen 6%, the remaining being incompressible. Determine weight of air required per kg of coal for chemically correct composition. (10)
- III. (a) In a single heater regenerative cycle the steam enters the turbine at 30 bar,  $400^{\circ}\text{C}$  and the exhaust pressure is 0.1 bar. The feed water heater is a direct-contact type which operates at 5 bar. Find (i) the efficiency and the steam rate the cycle and (ii) the increase in mean temperature of heat addition, efficiency and steam rate as compared to the Rankine cycle (without regeneration). Neglect pump work. (15)
- (b) Draw the T-s diagram of the Rankine cycle when steam supplied at the turbine is (i) dry saturated (ii) superheated (iii) wet with dryness fraction 'x'. (5)

OR

- IV. (a) What do you understand by hypothetical indicator diagram? Derive an expression to determine hypothetical mean effective pressure of a steam engine having clearance. (8)
- (b) A single cylinder double acting steam engine is supplied with steam at 11.5 bar and exhaust occurs at 1.1 bar. The cut-off occurs at 40% of the stroke. If the stroke is equal to 1.25 times the cylinder bore and the engine develops an indicated power of 60 kW at 90 rpm, determine the bore and stroke of the engine. Assume hyperbolic expansion and a diagram factor of 0.79. Also estimate the theoretical steam consumption in  $\text{m}^3/\text{min}$ . (12)

(P.T.O.)

- V. (a) Comment on the effect of friction in steam nozzles using h-s diagram. (5)  
 (b) Explain supersaturated flow through steam nozzles. (7)  
 (c) Dry saturated steam enters a nozzle at a pressure of 10 bar and with an initial velocity of 90 m/s. The outlet pressure is 6 bar and the outlet velocity is 435 m/s. The heat loss from the nozzle is 9 kJ/kg. Calculate the dryness fraction and the area at the exit, if the area at the inlet is  $1256 \text{ mm}^2$ . (8)

**OR**

- VI. (a) Differentiate impulse and reaction turbines. (5)  
 (b) In a De Laval turbine steam issues from the nozzle with a velocity of 1200 m/s. The nozzle angle is  $20^\circ$ , the mean blade velocity is 400 m/s, and the inlet and outlet angles of blades are equal. The mass of steam flowing through the turbine per hour is 1000 kg. Calculate (i) blade angles (ii) relative velocity of steam entering the blades (iii) tangential force on the blades (iv) power developed (v) blade efficiency. Take blade velocity coefficient as 0.8 (15)

- VII. (a) Derive an expression for critical radius of insulation of a cylinder. (8)  
 (b) Derive general heat conduction equation in Cartesian coordinates. (12)

**OR**

- VIII. (a) State and prove reciprocity theorem. (5)  
 (b) Explain the concept of black body. (5)  
 (c) Define Kirchhoff's law and prove it. (10)

- IX. (a) Explain Stanton number and Prandtl number. (10)  
 (b) Explain LMTD and assumptions made to derive expression for LMTD. (5)  
 (c) Differentiate coolers and condensers. (5)

**OR**

- X. (a) Explain Grashof number and Reynolds number. (8)  
 (b) The effective temperature of a black body having an area of  $0.12 \text{ m}^2$  is  $527^\circ\text{C}$ . Calculate the following. (12)  
 (i) The total rate of energy emission.  
 (ii) The intensity of normal radiation.  
 (iii) The wavelength of maximum monochromatic emissive power.