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10MR45

# Fourth Semester B.E. Degree Examination, June/July 2014
## Marine Heat Engines and Air Conditioning

Time: 3 hrs. Max. Marks:100

**Note:** ***Answer FIVE full questions, selecting at least TWO questions from each part.***



### PART – A

1 a. Explain the term 'compounding of steam turbine". **(02 Marks)**

b. Discuss the method of velocity-pressure compounding of an impulse turbine for achieving rotor speed reduction. **(06 Marks)**

c. Data pertaining to impulse turbine is as follows:
Steam velocity = 500 m/s Blade speed = 200 m/s
Exit angle of moving blade = 25° Nozzle angle = 20°.
Neglecting the effect of friction, draw velocity diagram and calculate:
i) Tangential force ii) Power obtained
iii) Blade efficiency iv) Specific steam consumption **(12 Marks)**

2 a. Define the following terms:
i) Diagram efficiency and ii) Stage efficiency **(04 Marks)**

b. Determine the condition for maximum efficiency of a 50 percent reaction turbine and show that the maximum efficiency for such a turbine is $2\cos^2\alpha / (1+\cos^2\alpha)$, where $\alpha$ is the angle at which the steam enters the blade. **(08 Marks)**

c. A Parson's turbine runs at 400 rpm with 50% reaction and it develops 75 kW of power per unit mass of steam flow per second. The exit angle of the blade is 20° and the steam velocity is 1.4 times the blade velocity. Draw velocity diagram and calculate: (i) blade velocity and (ii) inlet angle of blades. **(08 Marks)**

3 a. Why the Carnot cycle cannot be considered as the theoretical cycle for steam power plants even though its efficiency is maximum? **(04 Marks)**

b. Describe the Rankine vapour cycle and derive the expression for its efficiency. **(08 Marks)**

c. A simple Rankine cycle works between pressure of 30 bar and 0.04 bar, the initial condition of steam being dry saturated, calculate the cycle efficiency, work ratio and specific steam consumption. Use steam tables for necessary data. **(08 Marks)**

4 a. List out the desirable properties required for an ideal binary fluid used at higher temperatures. **(05 Marks)**

b. With the help of a line diagram, explain a binary vapour cycle. **(07 Marks)**

c. In a regenerative cycle, the steam pressure at turbine inlet is 30 bar and the exhaust is at 0.04 bar. The steam is initially saturated. Enough steam is bled off at the optimum pressure to heat the feed water. Determine the cycle efficiency. Neglect pump work. Draw proper T-S and h-s diagram. **(08 Marks)**

### PART – B

5 a. With the help of a neat sketch, explain the working of a constant volume combustion type gas turbine. **(07 Marks)**

b. Derive the equation for thermal efficiency of constant pressure closed cycle gas turbine. **(06 Marks)**

c. Explain in detail how regeneration leads to the improvement of thermal efficiency of simple open cycle constant pressure gas turbine plant. **(07 Marks)**

6 a. With a neat sketch explain the working principle of a centrifugal compressor. Also show the pressure and velocity variation of air while passing through the compressor. **(08 Marks)**

b. Define the following:
   i) Slip factors
   ii) Pressure coefficient **(04 Marks)**

c. A centrifugal compressor is desired to have a total pressure ratio of 3.5:1. The inlet eye of the compressor impeller is 30 cm in diameter. The axial velocity at inlet is 130 m/sec and the mass flow is 10 kg/sec. The velocity in the delivery duct is 115 m/sec. the tip speed of the impeller is 450 m/sec and runs at 16,000 rpm with total head isentropic efficiency of 78% and pressure co-efficient of 0.72. The ambient conditions are 1.013 bar and 15°C. Calculate:
   i) The static pressure ratio
   ii) The static pressure and temperature at inlet and outlet of compressor
   iii) Work of compressor per kg of air and
   iv) The theoretical power required. **(08 Marks)**

7 a. Differentiate between a refrigerator and a heat pump. **(05 Marks)**

b. Draw the layouts of a vapour compression refrigerating system. State the function of each of the component and show the thermodynamic processes on a pressure-enthalpy diagram. **(08 Marks)**

c. A vapour compression refrigerator works between the pressure limits of 60 bar and 25 bar. The working fluid is just dry at the end of compression and there is no under cooling of the liquid before the expansion valve. Determine: (i) C.O.P of the cycle and (ii) Capacity of the refrigerator if the fluid flow rate is 5 kg/min. Use the following data:

| Pressure bar | Saturation temperature, K | Enthalpy, kJ/kg | | Entropy, kJ/kgK | |
|---|---|---|---|---|---|
| | | Liquid | Vapour | Liquid | Vapour |
| 60 | 295 | 61.9 | 208.1 | 0.197 | 0.703 |
| 25 | 261 | -18.4 | 234.5 | -0.075 | 0.896 |

**(07 Marks)**

8 a. Define the following:
   i) Dry bulb temperature
   ii) Wet bulb temperature
   iii) Dew point temperature **(06 Marks)**

b. Define comfort. What are the factors which affect comfort air conditioning? **(06 Marks)**

c. A Sleeve psychrometer reads 40°C DBT and 28°C WBT. Assuming the barometric pressure as 1.013 bar, determine:
   i) Humidity ratio
   ii) Relative humidity
   iii) Dew point temperature
   iv) Enthalpy of the mixture per kg of dry air. **(08 Marks)**

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