INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)

May/ June 2017 End Semester Examinations

B.Tech. (Marine Engineering) Fourth Semester

(AY 2009-2014 batches)

Marine Heat Engines & Air Conditioning (UG11T1406/ UG11T2406)

Date : 22.06.2017 | Maximum Marks: 100

Time: 3 Hrs | Pass Marks : 50

Part – A **(10 x 3=30 Marks)**

(All questions are compulsory)

1. Explain the following questions with suitable free hand sketches wherever applicable
   (a) Air Standard Assumptions as applied to gas power cycle analysis.
   (b) Open Feed Water Heater in a steam power plant
   (c) Draw a TS diagram for a Closed Feed Water Heater - Rankine Cycle with reheat and label it.
   (d) What is a Reheat Factor as applied to steam turbines
   (e) What is an impulse action ? How is it different from reaction principle ?
   (f) With respect to psychrometry – Define humidity ratio and sensible heat
   (g) Draw a TS diagram for a ideal gas turbine cycle with intercooling, reheating and regeneration and label it.
   (h) Define One – Tonne Capacity of a Refrigerator and state its equivalent SI units
   (i) Define the efficiency of a steam nozzle
   (j) What is a throttling process ? State the energy conservation relationship for such a process

Part– B **(5 x 14 = 70 Marks)**

Answer any 5 (Five) questions

2. Power output from an ideal reheat-Rankine cycle is 2000kW. The steam enters the turbine at 15MPa and 450 deg.C and expands to 2MPa in an isentropic turbine. The steam is reheated to a temperature of 450^0 C and finally expanded to a condenser pressure of 100kPa in a second isentropic turbine. The feed pumps can be assumed to be isentropic. Calculate
   (a) The mass flow rate of the steam (2 marks)
   (b) The rate of heat transfer in the reheater (3 marks)
   (c) The power used by the pumps (3 marks)
   (d) The thermal efficiency of the cycle. (3 marks)
   (e) Draw the layout of the physical system and its TS diagram (3 marks)

3. An ideal reheat-regenerative Rankine cycle with open type feedwater heater is operating with a steam pressure of 10MPa and 550°C at inlet to the turbine. A certain fraction of the steam is bled off at 0.8MPa for regeneration. The remaining steam is reheated to 500°C and finally expanded to a condenser pressure of 100kPa. The condition of the feed water at the outlet of the regenerative reheater is saturated liquid. The pumps and turbines are assumed to be isentropic. Calculate

(a)The thermal efficiency of the cycle (5 marks)

(b)The total mass flow rate of steam for a power output of 80MW. (5 marks)

(c)Draw the physical layout and its TS diagram. (4 marks)

4. a) Derive the condition for maximum work output from a ideal Brayton cycle, given C_p (Specific Heat Capacity at Constant Pressure), T_L (Lowest Absolute Temperature in the cycle) and T_H (Absolute Highest Temperature in the cycle) . Assume cold air standard assumptions. (C_p is constant) (7 Marks)

b) What is the thermodynamic relation for work done on a compressor? Describe the effect of interstage cooling in a ideal compressor using a PV diagram. (7 Marks)

5. a) Derive the relationship between compressor pressure ratio, ratio of specific heats and thermal efficiency in a ideal Brayton Cycle using cold air standard assumptions. (C_p is constant) (7 Marks)

b) A gas turbine unit has air as the working fluid with a compressor pressure ratio 10. It operates between a high temperature of 700°C and a low temperature of 15°C. The isentropic efficiencies of the compressor and turbine are 0.82 and 0.85 respectively. The mass flow rate of the air is 15 kg/s. Calculate its power output. Use ratio of specific heats for air = 1.4 (compression process) and 1.333 (expansion process); specific heat at constant pressure, C_P = 1.005 kJ/kg K (compression) and C_P = 1.11 kJ/kg K (expansion) process. (7 Marks)

6. (a) The steam velocity leaving the nozzle is 590 m/s and the nozzle angle is 20°. The blade is running at 2800 rpm and blade diameter is 1050 mm. The axial velocity at rotor outlet = 155 m/s, and the blades are symmetrical. Calculate the work done, the diagram efficiency and the blade velocity coefficient. (7 Marks)

(b) Derive the condition for maximum efficiency from a Reaction turbine. Use the standard nomenclature for quantities assumed. (7 Marks)

7. (a) In one stage of an impulse turbine the velocity of steam at the exit from the nozzle is 460 m/s, the nozzle angle is 22^0 and the blade angle is 33^0. Find the blade speed so that the steam shall pass on without shock. Also find the stage efficiency and end thrust on the shaft, assuming velocity coefficient of 0.75, and blades are symmetrical.

(7 Marks)

(b) In a Parson's reaction turbine, the rotor of 1m diameter runs at 3000 rpm. Determine the isentropic enthalpy drop in the stage, considering a stage efficiency of 0.80, blade speed ratio of 0.7 and a blade outlet angle of 20^0. (7 Marks)

8. (a) Moist air, saturated at 2^0C enters a heating coil at a rate of 10 m^3/s. Air leaves the coil at 40^0C. Find the required rate of heat addition.

(7 Marks)

(b) A stream of 2 m^3/s of atmospheric air at 4^0C dry-bulb temperature and 2^0C thermodynamic wet-bulb temperature is adiabatically mixed with 6.25 m^3/s of re-circulated air at 25^0 C dry-bulb temperature and 50% RH. Find the dry-bulb temperature and thermodynamic wet-bulb temperature of the resulting mixture.(Use psychrometric charts)

(7 Marks)

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