B. E. PRODUCTION ENGG. 3RD YEAR 1ST SEMESTER EXAMINATION- 2019

ENERGY PRODUCTION SYSTEMS

Time: Three hours | Full Marks: 100

All parts of a question *(a, b, c* etc) should be answered at one place.
Assume any missing data with proper justification.

Answer any **FIVE** questions.

1.(a) Compare the open cycle and closed cycle gas turbine power plants.

(b) In an open cycle constant pressure gas turbine air enters the compressor at 1 bar and 300 K. The pressure of air after the compression is 4 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air-fuel ratio is 80. Calculate the work-ratio and thermal efficiency of the cycle. If the flow rate of air is 2.5 kg/s also calculate the power developed from the plant.

Take c_p= 1.005 kJ/kg-K and γ=1.4 for air
c_p= 1.147 kJ/kg-K and γ=1.33 for gases
R= 0.287 kJ/kg-K and Calorific Value of fuel= 42000 kJ/kg.

5+15=20

2.(a) Derive an expression of volumetric efficiency in terms of clearance ratio and pressure ratio if the suction and free air conditions are non-identical.

(b) A single cylinder double acting reciprocating air compressor has 20 cm bore and 25 cm stoke. Calculate the free air delivery (FAD) at 300 rpm when clearance volume is 600 cm^3 and delivery pressure is 5 bar. Assuming that n=1.3 and suction pressure and temperature are 1 bar and 30° C respectively find also the power required to drive the compression. Take free air conditions are 1.013 bar and 15° C.

8+12=20

3.(a) Differentiate between nozzle and diffuser.

(b) What do you mean by Reheat factor and Wilson line?-Explain

(c) What is the importance of Mach No. used in Nozzle?

(d) Calculate the throat diameter of a convergent-divergent nozzle, which will discharge 820 kg of steam per hour from a pressure of 8 bar superheated to 220° C into a chamber having a pressure of 1.05 bar. Frictional loss in the divergent part of the nozzle may be taken as 0.15 of the total enthalpy drop.

3+5+3+9=20

4.(a) Explain the velocity compounded impulse turbines with neat sketch?

(b) An impulse stage of steam turbine has a mean diameter of 1.2 m and speed of the rotor is 3000 rpm. The steam with a mass flow rate of 20 kg/s is supplied to the stage at 15 bar and 300° C where it expands to 10 bar. Determine the efficiency and power output of the stage if the nozzle efficiency is 90% and the blade velocity coefficient is 0.92. Assume the acceleration from the rest of the steam expanding in the nozzle and the nozzle angle to be 25°. Also assume the entry and exit blade angles are same.

5+15=20

[Turn over

5.(a) A reheat Rankine cycle operating between 30 bar and 0.04 bar has a superheat and reheat temperature of 450° C. The first expansion takes place till the steam is dry saturated and then reheat is given. Neglecting feed pump work determine the thermal efficiency of reheat cycle.

(b) In a stage of impulse-reaction turbine having a degree of reaction 0.5 the fixed and moving blades are of identical section and the blade exit angle is 18°. The absolute direction of discharge from the moving blades is 40 m/s in a direction 110° to the direction of motion of the blades and the change of velocity produced by the moving blades is parallel to that direction. Draw the velocity diagram and find (i) power developed for steam flow rate of 4 kg/s and (ii) stage efficiency if the frictional losses are of 25% of the kinetic energy corresponding to the relative velocity at the entry of each ring of blades and the expansion losses are 10% of the heat drop in the blades.

8+12=20

6.(a) Distinguish between the impulse turbine and reaction turbine.

(b) In a 50 percent reaction turbine stage running at 50 rps the exit angles and inlet angles are 30° and 50° respectively. The mean diameter of the blades is 1 m. The steam flows at 10000 kg/min and the stage efficiency is 85%. Determine (i) the power output of the stage, (ii) the specific enthalpy drop in the stage and (iii) the percentage increase in the relative velocity of steam when it flows over the moving blades.

6+14=20

7.(a) What are the different types of condensers used in thermal power plant? –discuss.

(b) What do you mean by vacuum efficiency and condenser efficiency?

(c) Discuss about the working of evaporative type condenser with neat sketch.

5+5+10=20

8. Answer any **FOUR** from the following: 4x5=20

(a) What are the conventional and non-cenvetional energy resources? - Discuss briefly.

(b) Describe the principle of Wind power generation with a neat sketch.

(c) Discuss briefly about the Nuclear cell used for generation of power.

(d) State the working principle of Magneto Hydrodynamic (MHD) systems.

(e) Explain the basic principle of Ocean Thermal Energy Conversion (OTEC) with a neat sketch.

(f) Illustrate the working principle of flat plate solar collector for generation of electricity.

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