Ref. No. : Ex/ME(M2)/PC/B/T/321/2024

B.E. MECHANICAL ENGINEERING THIRD YEAR SECOND SEMESTER - 2024

ENERGY CONVERSION SYSTEM

Time: 03 hours **Full Marks: 100**

Answers to all parts of a question must be together
Very brief and to-the-point answers will be given better credit
Use of steam tables and charts is allowed

Group – A
(Answer any one question from Group-A)

1. a) Draw possible Carnot cycles on T-s diagram of steam. Why is it practically difficult to achieve? 4+3
   b) What is mean temperature of heat addition of a Rankine cycle? Show it on a T-s diagram. 2+2
   c) What is regeneration in a steam power cycle? Show the simple layout and corresponding T-s diagram of a regeneration cycle. Does it increase both power output and efficiency? 3+2+2
   d) What is reheat in a steam power cycle? Show a single reheat steam power cycle on a T-s diagram. What are the advantages of reheat? 3+2+2

2. a) What are the effects of increasing boiler pressure with same maximum temperature of steam? Explain with a T-s diagram. 7
   b) A steam power station uses the following cycle: steam at turbine inlet 150bar, 550^{0}C. Reheat at 40bar to 550^{0}C. Condenser at 0.1bar. Assuming ideal processes, find (a) the quality of steam at turbine exhaust, (b) the cycle efficiency. 18

Group -B
(Answer any two questions from Group-B)

3. a) Why two types of analyses are required for coal? Explain. 4
   b) Why excess air is critical in coal combustion? How to determine the optimum excess air? 2+3
   c) Why two heating values are there for coal? Which one is more practical to use and why? 2+2
   d) What do you understand by equivalent evaporation? 2

4. a) What are the advantages and disadvantages of pulverized coal firing? Why large power station boilers are always pulverized coal fired? 2+2+2
   b) What is the advantage of using cyclone furnace? 1
   c) Why is attemperator needed with superheater? 3
   d) State different types of losses in a turbine. Which loss does not exist in reaction turbines and why? 4+1

5. a) With a neat sketch, explain the principle of speed governing of a steam turbine. 6

b) What are the main functions of a condenser in a steam power plant? With a neat sketch show the different components of a condensing plant of a steam power plant. How air is separated from steam in a condenser? 3+5+1

Group-C
(Answer any two questions from Group-C)

6. a) Assuming compressible flow, show that a converging shape is required for a nozzle with a negligible velocity of steam at the inlet. What are the other assumptions for this to happen? 6
b) A convergent-divergent nozzle receives steam at 7 bar, 200°C and expands up to 3 bar. Find out the throat area and exit area of the nozzle. Assume nozzle efficiency as 90% and mass flow rate 0.5 kg/s. 9

7. a) With a velocity diagram of a simple impulse turbine, determine the optimum velocity ratio and corresponding maximum efficiency. 7
b) In a two row velocity compounded impulse turbine, the moving blades have both inlet and exit angles 30^0 and the blade speed, nozzle angle and guide blade angles are so designed that the final discharge is axial. Velocity of steam from nozzle is 540 m/s. The friction factor is 0.9 for all the blade passages. Determine the blade speed. 8

8. a) What is the degree of reaction of a reaction turbine? Show that the stator and rotor blades are identical for a degree of reaction of 50%. 7
b) The discharge angle of blades of a 50% reaction turbine is 20^0. Mean speed of rotation is 3000 rpm, mean blade diameter is 1m. If the axial velocity of flow is to be 0.55 of the mean blade speed, determine a suitable receiving blade tip angle so that steam can enter the blade smoothly. If at a certain stage of this turbine, the blade height is 7.5cm and the mean condition of steam is given by 2.7bar, 0.95 dry, what would be the power developed by the turbine in that stage? 8

Group-D

9. Write short notes on any three of the following: 5x3=15
   a) Limitations of renewable energy,
   b) Significance of energy storage in renewable power,
   c) Source of energy of a nuclear power plant,
   d) Pressurized water reactor (PWR)