Ref. No. Ex/ME (M2)/PC/B/T/321/2023(S)

B.E. MECHANICAL ENGINEERING THIRD YEAR SECOND SEMESTER
SUPPLEMENTARY EXAM 2023

ENERGY CONVERSION SYSTEM

Time: Three hours Full Marks:100

(Use of steam table and charts are allowed.)

Question number 1 is compulsory. Answer any three questions from group-A and any one question from group-B

1..a) Draw the block diagram and T-s plot of a Reheat Rankine cycle. *6*

b) A steam power plant operates on the ideal Rankine cycle. Steam enters the high pressure turbine at 7 MPa and 500°C and leaves at 20 kPa with a mass flow rate of 1 kg/s. Determine the turbine work output, heat added in boiler, heat rejected in condenser, pump work, the thermal efficiency of the cycle, steam rate and heat rate. *14*

Group-A

2.a) Sketch and label a water tube boiler 10

b) A steam generator operates under the following conditions: coal analysis- C-60%, H-4%, S-1.5%, O-3%, M-4.5%, A-25%, N-2%; Dry Flue Gas analysis: CO2- 12%, CO-1.5%, O2- 7%, N2- 79.5%. Determine the % excess air used. 10

3.a) What do you mean by proximate and ultimate analysis of coal? 5

b) Explain the arrangement of straight flow burners with neat sketch. 7

c) Explain different types of boiler draught. Draw the sketch of air and flue gas pressure distribution for a balanced draught system 8

[Turn over

4.a) Derive the following relationship for isentropic expansion of steam through a nozzle-

$\frac{dA}{A} = (M^2 - 1)\frac{d\bar{V}}{\bar{V}} = (1 - M^2)\frac{dp}{\rho \bar{V}^2}$, where symbols denote their usual meanings. Explain the significance of the above equation for flow of steam with various Mach number through a passage of varying cross-sectional area. 10

b) Steam at 7 bar, 200^0 C expands isentropically in a convergent nozzle into a space at 3 bar. Neglecting the inlet velocity, estimate the exit area required for a mass flow rate of 0.1 kg/s. 10

5.a) Explain the pressure compounding for an impulse turbine with neat sketch. 10

b) An impulse steam turbine has nozzles inclined at 20^0 to the plane of rotation of the wheel. The blades are equiangular, the blade friction factor is 0.8 and the mean diameter of the wheel is 0.5 m. The steam leaves the nozzle with a velocity of 750 m/s. Determine the optimum value of the blade angles, the steam flow rate required to produce 20 kW and the blade efficiency. 10

Group-B

6.a) Define the following terms: load factor, capacity factor, demand factor, use factor and reserve factor. Establish the relationship between load factor, capacity factor and use factor. 8

b) The loads on a power plant with respect to time for 24 hours are given as follows:

Time (hours)	0–6	6–8	8–12	12–14	14–18	18–22	22–24
Load (MW)	40	50	60	50	70	80	40

Draw the load curve and find out the load factor of the power plant. If the loads above 50MW is taken by a standby unit of 20MW capacity, find the load factor and use factor of the standby unit. 12

7. a) What are the functions of condensers? 6
   b) Draw the sketch of a surface condenser 6
   c) What do you mean by a reflector in a nuclear reactor? 2
   d) Draw the sketch of a BWR type of a nuclear power plant. 6