Bachelor of Engineering (Mechanical Engineering) Third Year Second Semester Examination 2023

STEAM POWER PLANT

Time: Three hours   Full Marks: 100

Answer any five questions from the followings

All parts of the same question must be answered together

(Use of Steam table and charts are allowed)

Q1. (a) Define the following terms: Seam rate, Heat rate.

(b) A steam power plant operates on an ideal reheat cycle. The steam from the boiler at 150 bar and 550°C expands through the high pressure turbine. It is reheated at constant pressure of 40 bar to 550°C and expands through the low pressure turbine to a condenser pressure of 0.1bar. Draw *T-s* and *h-s* diagrams and find (i) quality of steam at turbine exhaust, (ii) thermal efficiency of the cycle and (iii) steam rate.   **(5+15)**

Q2. (a) Explain in brief various properties of coal.

(b) Prove that actual air-fuel ratio $W_A = 3.04 N_2 C_{ab} / (CO+CO_2)$, where the symbols denote their usual meaning.   **(10+10)**

Q3. (a) Sketch and label a modern (π-shaped) steam generator. Show clearly all heat transfer surfaces, air-fuel-flue gas and feed water steam circuit.

(b) What is fusible plug? Why it is used?   **(14+6)**

Q4. (a) Sketch a straight flow burner. Also explain the arrangement of straight flow burners.

(b) How does air preheater save fuel? With neat sketch explain working of a regenerative type of air preheater.   **(10+10)**

Q5. (a) Establish the relationship between area, pressure and velocity for flow through steam nozzle and draw the conclusions for M=1, M< 1, and M>1, where M is the Mach number.

(b) Steam at 30 bar, 350°C expands through a convergent-divergent nozzle. The exit plane pressure is 3 bar. The flow rate is 0.5 kg/s and the nozzle efficiency is 0.8. Assuming that the velocity at inlet is negligible, determine the throat and exit areas, steam velocity at the exit, and the quality of steam at the exit plane.   **(8+12)**

Q6. (a) Derive an expression of maximum blade efficiency for simple impulse turbine with relevant parameters.

(b) In a stage of an impulse turbine provided with single row wheel, the mean diameter of the blade ring is 850 mm and the speed of rotation is 3000 rpm. The steam issues from the nozzles with a velocity of 310 m/s and the nozzle angle is 21°. The blades are equiangular and the blade friction coefficient is 0.82. What is the power developed when the axial thrust on then blades is 120 N?

(8+12)

Q7. Write short notes on the followings (*any four*):   **(20)**
(a) Feed water heater, (b) Caking coal, (c) Boiler draft, (d) Economizer, (e) Bituminous coal.