Ref. No.: Ex/ME/5/T/321/2023(S)

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) THIRD YEAR
SECOND SEMESTER SUPPLEMENTARY 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. Answer the following questions:

(a) Why does reheating of steam become necessary? Explain the effect of reheat on cycle output and efficiency.

(b) What do you understand by *weatherability* of coal?

(c) State function of chimney in a natural draught boiler.

(d) Classify steam turbines based on the principle of working. **(20)**

Q2. (a) Explain with neat sketch a simple regenerative Ranking cycle.

(b) A steam power plant operates on a simple Rankine cycle between the pressure limits of 3 MPa and 50 kPa. The temperature of the steam at the turbine inlet is 300°C, and the mass flow rate of steam through the cycle is 35 kg/s. Assume an isentropic efficiency of 85% for both the turbine and the pump. Show the cycle on a *T-s* diagram with respect to saturation lines, and determine (i) the thermal efficiency of the cycle and (ii) the net power output of the power plant. **(8+12)**

Q3. (a) Explain the following terms: (i) proximate and ultimate analysis (ii) Blow off cock, fusible plug.

(b) The percentage analysis by mass of the coal used in a boiler was: Carbon 83, hydrogen 6, oxygen 5 and ash 6. The dry flue gas contained CO_2 10.50, CO 1.30, O_2 7.67 and N_2 80.53, % by volume. The temperatures of the air and flue gas were 15^0C and 215^0C respectively. Find the total mass of air supplied per kg coal. **(8+12)**

Q4. (a) Sketch and label a fire tube boiler. Show clearly all heat transfer surfaces, air-fuel-flue gas and feed water steam circuit.

(b) Differentiate between fire tube and water tube boilers. **(10+10)**

Q5. (a) Draw and explain a simple 'closed pulverization system'.

(b) State function of burners. Also classify burners. **(10+10)**

Q6. (a) Define and classify steam nozzles.

(b) Dry saturated steam at 10 bar is expanded in a convergent-divergent nozzle. The velocity of steam at exit is 685 m/s, the flow rate is 7 kg/s and the nozzle efficiency is 85%. Assume the flow to be isentropic up to the throat. Determine the throat and exit areas of the nozzle. Neglect the velocity of the steam at inlet. **(6+14)**

Q7. (a) Explain in brief with neat sketch working of a de-Laval steam turbine.

(b) A simple impulse turbine has one ring of moving blades running at 150 m/s. The absolute velocity of steam at exit from the stage is 85 m/s at an angle of 80^0 from the tangential direction. Blade velocity co-efficient is 0.82 and the rate of steam flowing through the stage is 2.5 kg/s. If the blades are equiangular, determine: (i) blade angles, (ii) nozzle angle, (iii) absolute velocity of steam issuing from the nozzle, (iv) axial thrust. **(8+12)**