BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING)
THIRD YEAR SECOND SEMESTER EXAM 2019
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 (***any four***):

(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) What is circulation ratio (CR)? Prove that CR=1/TDF, where TDF is top dryness fraction.

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

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

Q2. (a) Explain with neat sketch an ideal reheat Ranking cycle.

(b) A steam power plant operates on the reheat Rankine cycle. Steam enters the high-pressure turbine at 12.5 MPa and 550°C at a rate of 7.7 kg/s and leaves at 2 MPa. Steam is then reheated at constant pressure to 450°C before it expands in the low-pressure turbine. The isentropic efficiencies of the turbine and the pump are 85 percent and 90 percent, respectively. Steam leaves the condenser as a saturated liquid. If the moisture content of the steam at the exit of the turbine is not to exceed 5 percent, determine (a) the condenser pressure, (b) the net power output, and (c) the thermal efficiency. **(5+15)**

Q3. (a) Discuss various properties of coal.

(b) A steam generator operates under the following conditions: Ultimate analysis: carbon 60.0, hydrogen 4.0, nitrogen 2.0, sulphur 1.5, oxygen 3.0, moisture 4.5 and ash 25.0. Dry flue gas analysis: CO_2 12.0, CO 1.5, O_2 7.0 and N2 79.5%. Determine the excess air coefficient. **(8+12)**

Q4. (a) Explain with neat sketch a ball and race mill.

(b) Sketch and label a water tube boiler. Clearly show the feedwater-steam path, and fuel-air-flue gas path. **(10+10)**

Q5. (a) Establish a relationship between area, pressure and velocity for flow through steam nozzle.

(b) Steam at 30 bar, 350^0C 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 20^0. The blades are equiangular and the blade friction coefficient is 0.87. What is the power developed when the axial thrust on then blades is 150 N? **(8+12)**

Q7. Write short notes on the followings (***any four***): **(20)**

(a) Anthracite coal, (b) Orsat analyzer (c) Ultimate analysis (d) Straight flow burners, (e) Balanced draft system, and (f) Fusible plug.