

**B.E. MECHANICAL ENGINEERING (PART TIME) THIRD YEAR SECOND SEMESTER EXAM 2017**

**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) Show an ideal simple Rankine cycle on  $p$ - $v$ ,  $T$ - $s$  and  $h$ - $s$  planes.
- (b) What do you understand by *clinker* during combustion of coal?
- (c) What is circulation ratio (CR)? Prove that  $CR=1/TDF$ , where TDF is top dryness fraction.
- (d) Why the blades of impulse-reaction turbine made of unsymmetrical cross section?
- (e) State function of chimney in a natural draught boiler. (20)

**Q2.** (a) Explain with neat sketch an ideal reheat-regenerative Rankine cycle.

(b) A steam power plant operates on a theoretical reheat cycle. The steam from the boiler at 150 bar and  $550^{\circ}\text{C}$  expands through the high pressure turbine. It is reheated at constant pressure of 40 bar to  $550^{\circ}\text{C}$  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. (8+12)

**Q3.** (a) Explain desirable properties of coal for efficient combustion.

(b) Prove that actual air-fuel ratio  $W_A=3.04N_2C_{ab} / (CO+CO_2)$ , where the symbols denote their usual meaning. (10+10)

**Q4.** (a) State function of burners. Also classify burners.

(b) Explain Cochran boiler with neat sketch. (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,  $350^{\circ}\text{C}$  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 Parson's 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 800 mm and the speed of rotation is 3000 rpm. The steam issues from the nozzles with a velocity of 300 m/s and the nozzle angle is  $20^{\circ}$ . The blades are equiangular and the blade friction coefficient is 0.86. What is the power developed when the axial thrust on then blades is 140 N? (10+10)

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

- (a) Reheat cycle, (b) Feed water heater (c) Caking coal (d) Central coal pulverization system, (e) Boiler draft, and (f) Applications of nozzles.