

B.E. MECHANICAL ENGINEERING (PART TIME) THIRD YEAR SECOND
SEMESTER 2018

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 regenerative Rankine cycle on T -s and h -s planes.
- (b) What is ash softening temperature?
- (c) What do you mean by choking in a steam nozzle?
- (d) Why the blades of impulse turbine made of symmetrical cross section?
- (e) If the nozzle angle of a simple impulse turbine is 20° , determine the maximum blade efficiency of a simple impulse turbine with symmetric and frictionless blades. **(20)**

Q2. (a) Define the following terms: Steam rate, Heat rate.

- (b) A steam power plant operates on the ideal reheat Rankine cycle. Steam enters the high pressure turbine at 8 MPa and 500°C and leaves at 3 MPa. Steam is then reheated at constant pressure to 500°C before it expands to 20 kPa in the low-pressure turbine. Determine the turbine work output, in kJ/kg, and the thermal efficiency of the cycle. Also, show the cycle on a T -s diagram with respect to saturation lines. **(5+15)**

Q3. (a) Explain the effect of different coal constituent during combustion.

- (b) Derive an expression of stoichiometric air fuel ratio for a given ultimate analysis of coal with relevant parameters. **(10+10)**

Q4. Sketch and label a modern pi-shaped steam generator. Clearly show the feedwater-steam path, and coal-air-flue gas path. **(20)**

Q5. (a) Derive an expression of throat velocity for flow of steam through a convergent-divergent nozzle with relevant parameters. Also state the assumptions to derive the expression.

- (b) Dry saturated steam at 5 bar enters a convergent-divergent nozzle at a velocity of 100 m/s. The exit pressure is 1.5 bar. The throat and exit areas are 1300 mm^2 and 1600 mm^2 , respectively. Assuming isentropic flow up to the throat, estimate the mass flow rate and nozzle efficiency. **(8+12)**

Q6. (a) Explain in brief with neat sketch working of a velocity compounded impulse steam turbine.

- (b) The nozzles of the impulse stage of a turbine receives steam at 15 bar and 300°C and discharge it at 10 bar. The nozzle efficiency is 95% and the nozzle angle is 18° . The blade speed is that required for maximum work, and the inlet angle of the blades is that required for entry of the steam without shock. The blade exit angle is 5° less than that the inlet angle. The blade friction factor is 0.85. Calculate for a steam flow rate of 1500 kg/h, (i) the axial thrust, (ii) the diagram power and (iii) the diagram efficiency. **(8+12)**

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

- (a) Bituminous coal, (b) Economizer (c) Coal analysis (d) Circulation ratio, (e) Natural draft, and (f) Blow off cock.