Total No. of printed pages = 3

ME 181501

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30/12/22

2022

B.Tech 5th Semester End-Term Examination

M.E.

APPLIED THERMODYNAMICS – I

(New Regulation (w.e.f. 2017 - 2018) &

(New Syllabus (w.e.f. 2018 - 2019)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer question No. 1 and any *four* from the rest.

1. Choose the correct answer of the following MCQs: (10 × 1 = 10)

(i) For the same pressure ratio and considering the effect of frictional loss in steam nozzle, the dryness fraction of exit steam.

(a) increases (b) decreases

(c) remains same (d) first increases then decreases

(ii) The rate of flow of steam in case of a water tube boiler as compared to fire tube boilers is

(a) same (b) less

(c) more (d) none of the above

(iii) In impulse turbine steam expands in nozzle and its pressure while moving over the blades

(a) increases (b) decreases

(c) remains constant (d) none of these

(iv) Which one of the following components is not a boiler accessory?

(a) injector (b) superheater

(c) feed pump (d) safety valve

[Turn over

(v) The evaporative capacity of a steam generator may be expressed in terms of

(a) kg of steam/hour

(b) kg of steam/hr/m^2 of heating surface

(c) kg of steam/kg of fuel fired

(d) all of these

(vi) The reheat factor in a turbine working on steam power cycle depends on

(a) exit pressure only

(b) stage efficiency only

(c) initial pressure and temperature only

(d) all the above

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(vii) If specific stem consumption of a turbine working on Rankine cycle is 13 kg/kWHr then indicated work done per kg of steam is

(a) 277 kJ/kg (b) 27.65 kJ/kg

(c) 327 kJ/kg (d) 727 kJ/kg

(viii) The maximum blade efficiency of an impulse turbine under symmetrical blade without friction with a nozzle angle α is written as

(a) $\cos^2 \alpha$ (b) $\cos \alpha$

(c) $\cos 2\alpha$ (d) $\frac{\cos \alpha}{2}$

(ix) Maximum mass flow through a steam nozzle depends on

(a) initial condition of steam (b) exit area of nozzle

(c) final condition of steam (d) initial condition and throat area

(x) If the vacuum in a surface condenser is 71.5 cm of Hg and the barometer reading is 76.5 cm of Hg, then absolute pressure in the condenser is

(a) 0.068 bar (b) 0.68 bar

(c) 0.0068 bar (d) 6.8 bar

2. (a) Draw a suitable sketch of Cochran boiler and label the various components.

(b) A steam generator evaporates 18200 kg/hr of steam at 14 bar and a quality of 0.98 from feed water at 102°C when coal is burned at the rate of 2050 kg/hr. If efficiency of the steam generator is 65% then evaluate the caloric value of coal in kJ/kg used for steam generation. Also determine the efficiency of the steam generator when it generates dry saturated steam with same fuel and operating condition. (5+10=15)

3. (a) Draw the P-V and T-S diagram of a basic steam power plant cycle.

(b) Determine the efficiency of a modified steam power Rankine cycle having following data:

Steam delivery pressure = 15 bar at 300°C

Pressure at the end of expansion = 2 bar

Exhaust pressure = 1.1 bar (5+10=15)

4. (a) Describe in brief the influence of convergent and divergent part of a nozzle on steam velocity.

(b) Steam is expanded frictionless adiabatically in a steam nozzle from 5 bar and 400°C to 1 bar. If the initial velocity of steam entering the nozzle is 90 m/sec and nozzle efficiency is 88% then evaluate the exit velocity of steam. (5+10=15)

5. (a) Classify steam turbine on the basis of (i) action of steam and (ii) direction of steam flow.

(b) Following data are available for an impulse turbine. Evaluate the value of blade efficiency:

Mean diameter of blade = 1.4 m

Turbine speed = 3200 RPM

Nozzle angle = 20°

Inlet blade angle = 25°

Outlet blade angle = 18°

Blade velocity coefficient = 0.90 (5+10=15)

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6. (a) Classify steam condenser and explain any one of them with suitable diagram.

(b) Estimate the flow rate of cooling water in kg per hour in a condenser which takes 12,520 kg of steam per hour. The steam enters at 0.08 bar with dryness fraction 0.92. The condensate leaves at 37°C. The inlet temperature and outlet temperature of water flowing through the condenser are 13°C and 23°C respectively. (5+10=15)

7. (a) Prove that unavailable energy is the product of lowest temperature of heat rejection and the change of entropy during the process.

(b) Critically explain in brief about the difference between the terms Irreversibility and Effectiveness.

(c) Rate of energy input in a system is 7250 kJ/min. The source and system temperatures are 1000K and 500K, respectively. If atmospheric temperature is 300K, then determine the available energy of the source. (5+5+5=15)

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