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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: IV - CARRY OVER THEORY EXAMINATION - SEPTEMBER 2022

Subject: Applied Thermodynamics

Time: 3 Hours Max. Marks: 100

General Instructions:

1. The question paper comprises three sections, A, B, and C. You are expected to answer them as directed.
2. Section A - Question No- 1 is 1 marker & Question No- 2 carries 2 mark each.
3. Section B - Question No-3 is based on external choice carrying 6 marks each.
4. Section C - Questions No. 4-8 are within unit choice questions carrying 10 marks each.
5. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.
6. Use of Steam Table is permitted.

SECTION A 20

1. Attempt all parts:-

1-a. Fuel must be heated to its _____ before it starts burning. (CO1) 1

(a) ignition temperature

(b) burning temperature

(c) heating value

(d) heat capacity

1-b. A _____ is a device used to measure the amount of heat involved in a chemical or physical process. (CO1) 1

(a) Hydrometer

(b) Thermometer

(c) Calorimeter

(d) Ammeter

1-c. The draught in locomotive boilers is produced by a (CO2) 1

(a) Chimney

(b) Centrifugal fan

(c) Steam jet

(d) All of the mentioned

1-d. The vaccum obtainable in a condenser is dependent upon (CO2) 1

(a) Quantity of steam to be handeled

(b) Types of condenser used

(c) Capacity of ejector

(d) Temperature of cooling water

1-e. For a Rankine cycle, which of the following is true? (CO3) 1

(a) a reversible constant pressure heating process happens in steam boiler

(b) reversible adiabatic expansion of steam in turbine

(c) reversible constant pressure heat rejection in condenser

(d) all of the mentioned

1-f. In regenerative cycle feed water is heated by_____. (CO3) 1

(a) draining steam from the turbine

(b) draining steam from the pump

(c) draining steam from the condenser

(d) draining steam from the boiler

1-g. Nozzle used in rocket engine is _____. (CO4) 1

(a) convergent nozzle

(b) divergent nozzle

(c) convergent – Divergent nozzle

(d) none of the mentioned

1-h. Maximum efficiency in impulse steam turbine is _____. (where α = Nozzle angle). (CO4) 1

(a) Cos2α

(b) Cot2α

(c) Cosec2α

(d) Sin2α

1-i. Electronic control of gas turbine engines (CO5) 1

(a) increases efficiency

(b) helps in efficient working of gas turbine engine

(c) both (a) and (b)

(d) none of these

1-j. In an impulse turbine, steam expands (CO5) 1

(a) Wholly in nozzle

(b) Wholly in blades

(c) Partly in the nozzle and partly in blades

(d) None of These

2. Attempt all parts:-

2.a. Explain nuclear fuel with example. (CO1) 2

2.b. What is meant by boiler trial? (CO2) 2

2.c. Define ram compression. (CO3) 2

2.d. Why are steam turbines compounded? (CO4) 2

2.e. Why computer-based boiler performance monitoring system was developed? (CO5) 2

SECTION B 30

3. Answer any five of the following:-

3-a. Explain the meaning of Stoichiometric air-fuel ratio with the help of an example. Also define the effect of insufficient air supply during the combustion process. (CO1) 6

3-b. What is meant by adiabatic flame temperature? Also, explain effect of temperature on standard heat of reaction. (CO1) 6

3-c. Explain the function of feed water heater, economizer, air preheater and super-heater in a high pressure boiler. (CO2) 6

3-d. State the functions of a condenser in a stream power plant and also explain the working of any one type of condenser with the help of a suitable diagram. (CO2) 6

3.e. In an air standard gas turbine engine, air at a temperature of 15°C and a pressure of 1.01 bar enters the compressor, where it is compressed through a pressure ratio of 5. Air enters the turbine at a temperature of 815°C and expands to original pressure of 1.01 bar. Determine the ratio of turbine work to compressor work and the thermal efficiency when the engine operates on ideal Brayton cycle. Take : $\gamma = 1.4$, Cp = 1.005 kJ/kg K. (CO3) 6

3.f. What are the losses during the working of steam turbine? (CO4) 6

3.g. State the pros and cons of electrically actuated nozzles. (CO5) 6

SECTION C 50

4. Answer any one of the following:-

4-a. What is the use of calorimeter? A molten metal of mass 150 g is kept at its melting point 800 10

°C. When it is allowed to freeze at the same temperature, it gives out 75000 J of heat energy. What is the specific latent heat of the metal? If the specific heat capacity of metal is 200 J/kg/K, how much additional heat energy will the metal give out in cooling to – 50 °C ? (CO1)

4-b. Explain: a) Heat of reaction b) Heat of formation c) Significance of adiabatic flame temperature d) Fuel air ratio e) Fuel (CO1) 10

5. Answer any one of the following:-

5-a. What are boiler mountings? State the location and function of a) Water level indicator b) Pressure gauge c) Feed check valve d) Manhole e) Safety valve (CO2) 10

5-b. Explain the role of boiler draught in improving the efficiency of a boiler. Also explain the role of forced draught fan and Induced draught fan in creation of artificial draught with the help of neat line diagram.(CO2) 10

6. Answer any one of the following:-

6-a. A steam power plant operates on Rankine cycle with steam entering the turbine at 40 bar, 350°C and leaving at 0.05 bar. Steam leaving the turbine condenses to saturated liquid inside the condenser. Determine the net work per kg of steam, pump work per kg of steam and the cycle efficiency assuming all the processes to be ideal. Also show cycle on T-s diagram. (CO3) 10

6-b. In a Rankine cycle, the steam at inlet to turbine is dry saturated at a pressure of 35 bar and leaves the turbine at a pressure is 0.2 bar. Assume flow rate of 9.5 kg/s.
Determine : a) Pump work b) Turbine work c) Rankine cycle efficiency d) Heat rejected in the condenser e) The dryness fraction of steam at the end of expansion in the turbine. (CO3) 10

7. Answer any one of the following:-

7-a. Explain the role of compounding in the turbines. Also discuss the effect of velocity compounding with the help neat sketch diagram. (CO4) 10

7-b. An impulse steam turbine of 200 kW has steam flowing at rate of 160 kg/min and leaving axially. Steam turbine blade speed is 170 m/s and it leaves nozzle at 300 m/s. For the blade velocity coefficient of 0.9 find nozzle angle, blade angle at inlet and exit, axial thrust. (CO4) 10

8. Answer any one of the following:-

8-a. Explain the electronic control of gas turbine engines with the help of neat sketch diagram. (CO5) 10

8-b. Explain the working of automatic spray nozzles with the help of neat sketch diagram. (CO5) 10