B.TECH/EE/4TH SEM/ELEC 2203/2018

THERMAL POWER ENGINEERING
(ELEC 2203)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

USE STEAM TABLE, MOLLIER CHART WHEREVER NECESSARY.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The main purpose of the reheat cycle is to
(a) increase the work output per kg of steam
(b) raise the maximum cycle pressure
(c) obtain higher cycle efficiency
(d) decrease the moisture content at the turbine outlet.

(ii) The mean piston speed of a four stroke diesel engine running at 1500 rpm with stroke of 80 mm is
(a) 240 m/min (b) 240 m/s (c) 240 cm/min (d)240mm/min.

(iii) The component of IC engine which gives power to non-power strokes is
(a) spark plug (b) flywheel
(c) carburettor (d) fuel injection pump.

(iv) The ratio of work done per cycle to the swept volume is called
(a) compression ratio
(b) brake thermal efficiency
(c) volumetric efficiency
(d) mean effective pressure.

(v) Unit of break specific fuel consumption is
(a) kg/hr (b) kg/km (c) kg/kW (d) kg/kWh.

(vi) Steam is expanded in a set of nozzles from 10 bar 200°C to a pressure which gives maximum discharge. The pressure of steam coming out of nozzle is
(a) 20 bar (b) 5.5 bar (c) 0.5 bar (d) 5kPa.

(vii) In four stroke IC engine, cam shaft rotates at
(a) the same speed as crankshaft
(b) twice the speed of crankshaft
(c) half the speed of crank shaft
(d) none of these.

(viii) Which of the followings is not present in a super-critical boiler?
(a) Economizer (b) Evaporator
(c) Superheater (d) None of the options.

(ix) Opening the intake valve before the top dead centre improves
(a) power output
(b) brake thermal efficiency
(c) volumetric efficiency
(d) all of these.

(x) In case of impulse turbine enthalpy drop occurs
(a) both in fixed and moving blades (b) only in moving blades
(c) only in nozzles (d) none of these.

Group – B

2. (a) A steam power plant working on the Rankine vapour cycle operates between 40 bar and 0.05 bar. If the steam supplied at the turbine inlet is dry saturated, find (i) thermal efficiency, and (ii) specific steam consumption.
Plot the cycle on the T – s diagram.

(b) What are the *essentials* of a good steam boiler? State the *main* difference between (i) *externally* fired and *internally* fired boiler, and, (ii) *forced* circulation and *natural* circulation boiler.

(4 + 2 + 1) +(3 +1 +1)=12

3. (a) A steam power station uses the following cycle:
Condition of steam at boiler outlet: 150 bar, 550^0C; reheat is carried out at 40 bar to 550^0C ; condenser is operated at 0.1 bar.
Assuming ideal processes, find the (i) quality of steam at turbine exhaust, (ii) cycle efficiency, and (iii) steam rate.

(b) State two commonly used methods for the burning of coal. State any two factors upon which selection of any coal burning method depends. Also state two advantages of stoker firing over hand firing.

(2+ 2 + 2) +(2 + 2 +2) =12

Group – C

4. (a) The steam used by a turbine is at a 5.4 kg/ kWh pressure of 50 bar and a temperature of 350^0C. The temperature of the feed water is 150^0C . The boiler efficiency is 82%. Find:
(i) How much quantity of coal (calorific value 28,100 kJ/kg) is required/kWh?
(ii) If the cost of coal / tonne is Rs.1500 is , what is the fuel cost /kWh ?

(b) A surface condenser is designed to handle 16,000 kg of steam per hour. The steam enters the condenser at absolute pressure of 0.09 bar and 0.88 dryness fraction. The condensate leaves the condenser at the corresponding saturation temperature. Determine the rise in cooling water temperature, if the cooling water flow rate is 8.96×10^5 kg/hr . Assume that the pressure is constant (head loss neglected).

(3 +2) + 5 +2=12

5.(a) The percentage composition of a sample of liquid fuel is C = 84.8%, H_2=15.2% by mass. Calculate (i) the minimum mass of air needed for complete combustion of 1 kg fuel, (ii) the volumetric composition of the products of combustion if 15 percent excess air is supplied.

(b) (i) The outlet and inlet temperatures of cooling water to a condenser are 37.5^0C and 30.5^0C respectively. If the vacuum in the barometer is 706 mm of mercury with the barometer reading 760 mm , determine the condenser efficiency. (ii) Explain in brief the principle of operation of an electrostatic precipitator.

(2 + 3) + (3 + 4) =12

Group – D

6. (a) Dry air at a temperature of 25°C and pressure of 20 bar enters a nozzle and leaves at a pressure of 4.2 bar. Find the mass of air discharged if the area of the nozzle is 220 mm^2.

(b) The following data relate to a compound impulse turbine having two rows of moving blades and one row of fixed blades in between them.
The velocity of steam leaving the nozzle : 600m/s
Blade speed : 125m/s
Nozzle angle : 20°
First moving blade discharge angle : 20°
First fixed blade discharge angle : 25°
Second moving blade discharge angle : 30°
Friction loss in each ring =10% of the relative velocity.
Find (i) diagram efficiency (ii) power developed for a steam flow rate of 6 kg/s.

4 + 8=12

7. (a) What is the main function of a governor in a steam turbine? Draw a simple centrifugal fly ball governor and explain how the speed of steam turbine is maintained.

(b) Steam at 20 bar, 400°C expands in a steam turbine to 0.1 bar. There are four stages in the turbine and the total enthalpy drop is divided equally among the stages. The stage efficiency is 75% for all stages. Determine the inter-stage pressures, the reheat factor and the turbine internal efficiency.

(1 + 5) + 6=12

Group – E

8. (a) Draw the p-V and T-s diagrams of Otto and Diesel cycles under the following conditions and state the reasons for which one is better than the other.
(i) same compression ratio and heat addition
(ii) same compression ratio and heat rejection.

(b) Fuel supplied to an SI engine has a calorific value 42000 kJ/kg. The pressure in the cylinder at 30% and 70% of the compression stroke are 1.3 bar and 2.6 bar respectively. Assuming that the compression follows the law $pv^{1.3}$ = constant, find the compression ratio. If the relative efficiency of the engine compared with the air standard efficiency is 50%, calculate the fuel consumption in kg/kWh.

(2 + 2) + 8 = 12

9. (a) Define volumetric efficiency of an internal combustion engine. What does an internal combustion engine with higher volumetric efficiency signify with respect to the following factors? (i) Pollutant emission (ii) Degree of combustion of fuel (iii) Power output.

(b) A single cylinder 4-stroke cycle oil engine works on diesel cycle. The following readings were taken when the engine was running at full load :
Area of indicator = 3 cm^2,
Length of the diagram=4cm,
Spring constant = 10 bar/cm^2-cm,
Speed of the engine = 400 r.p.m.,
Load on the brake = 380N,
spring reading = 50N,
Diameter of the brake drum = 120 cm,
Fuel consumption = 2.8 kg/hr ,
Calorific value of fuel = 42,000 kJ/kg,
Diameter of the cylinder = 16 cm,
Stroke of the piston = 20 cm
From the above given data, find (i) F.P. of the engine (ii) mechanical efficiency (iii) brake thermal efficiency and (iv) brake mean effective pressure.

(1+3) + 8 = 12