C 14741 (Pages : 3) Name.....

Reg. No.....

SIXTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION DECEMBER 2010

ME 04 601—IC ENGINES AND GAS TURBINES

(2004 admissions)

Time : Three Hours Maximum : 100 Marks

Answer **all** *questions.*

1. (a) Discuss the important features that distinguish four-stroke cycle internal combustion engine from two-stroke cycle internal combustion engine.

   (b) Explain valve timing diagram for four-stroke cycle spark ignition engine.

   (c) Describe the methods of measuring the heat lost in exhaust gases of an I.C. engine.

   (d) Define volumetric efficiency as applied to petrol engine. How does the volumetric efficiency of an engine limit the power output.

   (e) Explain the phenomena of knocking in S.I. engine. What are the different factors which influence the knocking ? Describe the methods used to suppress it.

   (f) What is meant by ignition delay ? Name and describe the *two* components of ignition delay period.

   (g) Explain with neat sketch closed cycle gas turbine plant.

   (h) Discuss with the help of graphs, the variations or cycle thermal efficiency with pressure ratio at various maximum cycle temperatures for gas turbine plant.

   (8 × 5 = 40 marks)

2. (a) Show that the compression ratio for the maximum work to be done per kg of air in an Otto cycle between upper and lower limits of absolute temperatures T_3 and T_1 is given by :

$$R_c = \left(\frac{T_3}{T_1}\right)^{\frac{1}{2}(Y-1)}$$

   (7 marks)

   (b) Find the air standard efficiency of the cycle when the cycle develops maximum work with the temperature limit of 300 K and 1200 K and working fluid is air. What will be the percentage change in the efficiency and work done if helium is used as working fluid instead of air ? The cycle operates between the same temperature limit for maximum work development.

   (8 marks)

Or

Turn over

(c) An oil engine works on the Dual cycle. The compression ratio is 10 and expansion ratio is 5.5. The initial pressure and temperature of the air are 1 bar and 300 K. The heat liberated at constant volume.

The expression and compression follow the law $PV^{1.3} = C$. Find the following :

(a) Pressure and temperature at all salient points.

(b) Mean effective pressure of the cycle.

(c) Efficiency of the cycle.

(d) The power if working cycles are 500/min and d = 24 cm and L = 40 cm.

(15 marks)

3. (a) The following observations were made during as test on a two-stroke cycle oil engine :—

Room temperature	...	20°C
Bore	...	20 cm
Stroke 25 cm		
Speed	...	350 r.p.m.
Brake drum diameter	...	1.2 m
Net brake load	...	450 N
Mean effective pressure	...	2.8 bar
Oil consumption	...	3.6 kg/hr
Calorific value of oil	...	41800 kJ/kg
Quantity of jacket cooling water	...	455 kg/hr
Rise in temperature of jacket water	...	28°C
Temperature of exhaust gases entering the exhaust gas calorimeter	...	320°C
Temperature of exhaust gas having the exhaust gas calorimeter	...	220°C
Quantity of water passing through exhaust gas calorimeter	...	8 kg/min
Temperature rise of calorimeter water	...	8°C

Determine the indicated abd brake power mechanical efficiency and brake thermal efficiency up a heat balance on one minute basis.

Or

(b) The air consumption of a 30 kW four-stroke engine working on the four-stroke cycle is measured by means of a circular orifice of diameter 3.8 cm. The coefficient of discharge for the orifice is 0.6 and the pressure across the orifice is 14.5 cm of water. The barometer reading is 75 cm of Hg and air temperature 24°C. The swept volume of the engine cylinder is 2210 cm^3 and the compression ratio is 6.4. The consumption is 0.13 kg/min and the engine speed is 2500 r.p.m. The calorific value is 44,000 kJ/kg.

Determine :

(a) Air-fuel ratio. (b) $\eta_{volumetric}$

(c) P_M (Brake) (d) $\eta_{relative}$.

(15 marks)

4. (a) Discuss the important features that distinguish four-stroke cycle internal combustion engine from two-stroke cycle internal combustion engine.

(8 marks)

(b) Explain the valve timing diagram for four-stroke cycle spark ignition engine. (7 marks)

Or

(c) What do you understand by the terms "pre-ignition' and "detonation" ? Sketch indicator diagrams to illustrate their effect.

(8 marks)

(d) Discuss briefly the factors which may influence detonation in a petrol engine, illustrating with sketches the influence of the forms of combustion chambers.

(7 marks)

5. (a) In a gas turbine plant the ratio of T_{max}/T_{min} is fixed. Two arrangements are to be investigated :

(i) Single stage compression followed by expansion in two turbines of equal pressure ratios with reheat to the maximum cycle temperature, and

(ii) Compression in two compressors of equal pressure-ratios with intercooling to minimum cycle temperature followed by single-stage expansion.

If η_c and η_T are the compressor and turbine is entropic efficiencies, show that the optimum specific output is obtained at the same overall pressure ratio for each arrangement.

(15 marks)

Or

(b) The following data apply to a gas turbine set employing a heat exchanger isentropic efficiency of compressor = 0.83, Isentropic efficiency of Turbine = 0.85. Mech. transmission efficiency, combustion efficiency = 0.98, H.E. effectiveness = 0.80, Pressure ratio = 4.0, Maximum cycle temperature = 1100 K, Ambient conditions = 1 bar and 288 K Lower heating value of fuel = 43,100 kJ/kg.

Take C_P = 1.005 kJ/kg K, r = 1.4 during compression

and C_P = 1.147 kJ/kg-K, r = 1.33 during compression and expansion.

Calculate specific work output, specific fuel consumption and cycle efficiency. Neglect all losses.

(15 marks)

[4 × 15 = 60 marks]