BTS(C) – V(S) – 11 – 037 - M

B. Tech Degree V Semester (Supplementary) Examination June 2011

ME 504 THERMAL ENGINEERING

(2006 Scheme)

Time : 3 Hours Maximum Marks : 100

PART - A

(Answer *ALL* questions)

$(8 \times 5 = 40)$

I. (a) Compare the relative merits and demerits of different scavenging systems.
(b) Discuss the effect of spark advance on the performance of an Otto cycle engine. What is optimum spark advance?
(c) Describe the Buchi system of turbo charging.
(d) What is meant by combustion induced swirl? Show with sketches two important designs of CI combustion chamber using this method of swirl.
(e) Obtain the relation between initial pressure of steam and pressure at throat for maximum discharge.
(f) Define speed ratio, blade velocity co-efficient, blade efficiency in connection with steam turbine.
(g) What is the effect of pressure ratio on the efficiency of a regenerative cycle? At what pressure ratio the regenerator becomes superfluous?
(h) How stabilization of flame is obtained in a typical gas turbine combustion chamber? Show by a sketch the flow patterns in a typical combustion chamber.

PART – B

$(4 \times 15 = 60)$

II. A full load test on a two-stroke engine yielded the following results: (15)
Speed, 450 rev/min; brake load, 450N; imep, 2.9 bar; oil consumption, 5.4 Kg/h; rise in temperature of jacket water, 36.1°C; jacket water flow, 440 Kg/h; air fuel ratio by mass, 31; temperature of exhaust gases, 355°C; temperature of the laboratory, 20°C; barometer pressure, 76 cm Hg.
The following data applied to the test.
Cylinder diameter, 22cm; stroke, 27cm; brake diameter, 1.5m; calorific value of fuel, 44000KJ/Kg; proportion of hydrogen by mass in the fuel, 15; R=0.287 KJ/Kg K for air; mean specific heat of dry exhause gases, 1.005; specific heat of dry steam, 2.05 KJ/Kg.K.
Determine (i) The indicated thermal efficiency
(ii) The specific fuel consumption in gm/KWh
(iii) The volumetric efficiency based on atmospheric conditions.

Draw a heat balance for the test on percentage basis indicating carefully the content of each item in the balance.

OR

III. A six cylinder four stroke petrol engine has a swept volume of 300 cm^2 per cylinder, a compression ratio of 10 and operates at a speed of 3500 rev/min. If the engine is required to develop an output of 75KW at this speed, calculate the cycle efficiency, the necessary rate of heat addition, the mean effective pressure and the maximum temperature of the cycle. Assume that the engine operates on the Otto cycle and that the pressure and temperature before isentropic compression are 1 bar and 150°C respectively. Take $C_v = 0.718$ and $\gamma = 1.4$. (15)

If the above engine is a compression - ignition engine operating on the diesel cycle and receiving heat at the same rate, calculate efficiency, the maximum temperature of the cycle, the power out put and the mean effective pressure.

IV. (a) What action can be taken with regard to the following variables, in order to reduce the possibility of detonation in an SI engine? Justify your answers by reasons: (8)
(i) Compression ratio
(ii) Mass of charge induced
(iii) Mixture inlet temperature
(iv) Combustion chamber wall temperature
(v) Spark timing
(vi) Turbulence
(vii) Engine speed
(viii) Distance of flame travel

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(b) Explain the terms (i) lead susceptibility (ii) lead antagonism (iii) sensitivity (3)

(c) How do the injection timing and the fuel quality affect the engine knock? (4)

OR

V. (a) "Factors tending to increase detonation in SI engines tend to reduce knock in CI engines". Discuss the validity of the above statement in the light of the differences in the nature of the two phenomenon and indicate the methods used to reduce knock in CI engines. (4)

(b) What is meant by crankcase blowby? How it can be controlled? (3)

(c) The entire output of a supercharged 4 stroke oil engine is used to drive an air compressor. The air enters the compressor at 20^0C and is delivered to a cooler which removes heat at the rate of 1340 KJ/min. The air leaves the cooler at 60^0C and 1.72 bar. Part of this air flow is used to supercharge the engine which has a volumetric efficiency of 0.70 based on induction manifold condition of 60^0C and 1.72 bar. The engine which has 6 cylinders of 90mm bore and 100mm stroke runs at 2000 rev/min and delivers an output torque of 147 Nm. The mechanical efficiency of the engine is 0.75. (8)
Determine (i) the engine indicated mean effective pressure (ii) the air consumption in Kg/min and (iii) air flow into compressor in Kg/min.

VI. One stage of an impulse turbine consists of a converging nozzle and one ring of movable blades. The nozzles are inclined at 22^0 to the blades whose tip angles are both 35^0. (15)

(i) If the velocity of the steam at exit from the nozzle is 660 m/s, find the blade speed so that the steam shall pass on without shock and find the diagram efficiency, neglecting the losses, if the blades run at this speed.

(ii) If the relative velocity of steam to the blade is reduced by 15% in passing through the blade ring, find the efficiency and the end thrust on the shaft when blade ring develop 2320 h.p.

OR

VII. (a) Explain supersaturated flow in nozzles. (4)

(b) Define critical pressure, critical temperature and critical speed of steam flow through a nozzle. (4)

(c) Dry saturated steam at a rate of 1 Kg/s flows through a convergent nozzle with initial pressure of 8 bar. The exit pressure of the nozzle is 2 bar and flow is isentropic. Calculate exit area and dryness fraction. (7)

VIII. In a double-sided centrifugal compressor the following data is given: (15)

Overall diameter of impeller	= 50cm
Eye tip diameter	= 30cm
Eye root diameter	= 15cm
RPM	= 15000
Total mass flow	= 18 Kg/s
Inlet total head temperature	= 295 K
Total head isentropic efficiency	= 78%
Power input factor	= 1.04
Slip factor	= 0.9

Find (i) the total head pressure ratio;
(ii) the hp required to drive the compressor;
(iii) the inlet angles of the vanes at the root and tip impeller eye.

Assume that velocity of air at inlet is 150 m/s and is axial and remains constant across the eye annulus.

OR

IX. (a) Show that the specific work output of a simple gas turbine cycle is maximum when the pressure ratio is such that the compressor and turbine outlet temperatures are equal. (5)

(b) In an open cycle gas turbine plant, air at 15^0C and 1.013 bar is compressed through a pressure ratio 5:1. The maximum temperature of the cycle is 8000^0C and gas expands in two turbine stages to the original pressure, with reheating at constant pressure of 2.265 bar to 800^0C between the stages. The air compressed in 2 stages, with complete inter cooling division being made for optimum conditions. The isentropic efficiencies of the compressors and turbines are 0.8 and 0.9 respectively. Determine (i) power for mass flow of 20 Kg/s (ii) Overall thermal efficiency (iii) Air fuel ratio. Assume C_p=1.005 throughout the cycle and calorific value of fuel = 41800 KJ/Kg. (10)

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