B.E. / B.Tech DEGREE END SEMESTER EXAMINATIONS, APRIL/ MAY 2011

MECHANICAL ENGINEERING BRANCH

FOUTH SEMESTER – (REGULATIONS 2008)

ME 9254 THERMAL ENGINEERING - I

**INSTRUCTIONS**

Assume any data required suitably with proper justification

**Time : 3 Hrs** **Max Marks : 100**

**Answer All Questions**

**PART A** (10 x 2 = 20 Mark)

1. How do you compare the compression ratio of Otto Cycle with Diesel Cycle for the same maximum pressure?
2. Draw the Fanno Curve on the T-s diagram and label all the important states and processes.
3. If the clearance ratio of an adiabatic compressor is 8%, what is the volumetric efficiency for a pressure ratio of 10?
4. What is the significance of Isothermal efficiency of a reciprocating compressor?
5. What is the function of Connecting Rod and Timing Gear in IC Engines?
6. Why does four stroke engine demand for bigger size Flywheel, compared to two stroke engine?
7. What is the Ignition Delay requirement for the fuels of SI and CI engines?
8. Why is 2 stroke engines considered to be more pollutive, compared to 4 stroke engines?
9. How does the cycle efficiency of Simple Brayton Cycle depend on pressure ratio?
10. What is meant by effectiveness of Regenerator in Gas Turbines?

**PART B** (5 x 16=80 Mark)

11). In an engine working on Dual Cycle, the temperature and pressure at the beginning of the cycle are 90°C and 1 bar respectively. The compression ratio is 9. The maximum pressure is unlimited to 68 bar and total heat supplied per kg of air is 1750 kJ. Determine: (i) pressure and temperature at all salient points, (ii) specific work output and specific heat input (iii) Air standard efficiency and (iv) Mean effective pressure (4x4)

12) a) (i) Describe the influence of clearance volume on specific work consumption and volumetric efficiency of a reciprocating compressor. (6)

(ii) A single stage double acting air compressor has a free air delivery (FAD) of 14 $m^3$/min measured at 1.013 bar and 15°C. The pressure and temperature in the cylinder during induction are 0.95 bar, 32°C. The delivery pressure is 7 bar, and index of compression and expansion is 1.3. The clearance volume is 5% of swept volume. Calculate i) Volumetric efficiency ii) Cylinder dimensions if L=1.2D and iii) power required to drive the compressor. (10)

**(OR)**

b)i)Briefly discuss the significance of intercooling and multistage compression process in a reciprocating air compressor. (6)

(ii) A two-stage single-acting reciprocating compressor takes in air at the rate of 0.2 $m^3$ /s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a final pressure of 0.7 MPa. The intermediate pressure is ideal and intercooling is perfect. The compression index in both the stages is 1.25 and the compressor runs at 600 r.p.m. Neglecting clearance, determine, the intermediate pressure, the power required to drive the compressor and the rate of heat rejection in the intercooler. Take $c_p$ as 1.005 kJ / kg K and R as 0.287 kJ / kg K (10)

13) a) (i) Give complete classification of IC engines (6)

(ii) Draw the actual valve timing diagram of a petrol engine and explain the reason for its deviation from the theoretical diagram. (10)

**(OR)**

b) (i) List the Challenges faced by Two stroke engines. (6)

(ii) Compare SI engines with CI engines, based on (i) components, (ii) process parameters, (iii) performance and (iv)applications. (10)

14) a)A four cylinder four-stroke S.I. engine has a compression ratio of 8 and bore of 100 mm, with stroke equal to the bore. The volumetric efficiency of each cylinder is equal to 75%. The engine operates at a speed of 4800 r.p.m. with an air-fuel ratio 15.Given that the calorific value of fuel = 42 MJ / kg, atmospheric density = 1.12 kg/$m^3$ ,mean effective pressure in the cylinder = 10 bar and mechanical efficiency of the engine = 80%, determine i) the indicated thermal efficiency and ii)the brake power.

**(OR)**

b)During the trial of a single-acting oil engine, cylinder diameter 200 mm, stroke 280 mm, working on two-stroke cycle and firing every cycle, the following observations were made:

| | | |
|---|---|---|
| Duration of trial | : | 1 hour |
| Total fuel used | : | 4.22 kg |
| Calorific value | : | 44670 kJ / kg |
| Preparation of hydrogen in fuel | : | 15% |
| Total number of Revolutions | : | 21000 |
| Mean effective pressure | : | 2.74 bar |
| Net brake load applied to a drum of 1 m diameter | : | 600 N |
| Total mass of cooling water circulated | : | 495 kg |
| Inlet temperature of cooling water | : | 13°C |

| | | |
|---|---|---|
| Outlet temperature of cooling water | : | 38°C |
| Air used | : | 135 kg |
| Temperature of air in test room | : | 20°C |
| Temperature of exhaust gases | : | 370°C |

Assume : $C_p$ (gases) = 1.005 kJ / kg K; :$C_p$ (steam) at atmospheric pressure = 2.093 kJ / kg K
Calculate the thermal efficiency and draw up the heat balance.

15) a)i) Compare open and closed cycle gas turbine. (6)

ii)The gas turbine has an overall pressure ratio of 5:1 and a maximum cycle temperature of 550°C. The turbine drives the compressor and an electric generator, the mechanical efficiency of the drive being 97%. The ambient temperature is 20°C and the isentropic efficiencies for the compressor and turbine are 0.8 and 0.83 respectively. Calculate the power output in kilowatts for an air flow of 15 kg/s. Calculate also the thermal efficiency and the work ratio. Neglect changes in kinetic energy, and the loss of pressure in combustion chamber. (10)

**(OR)**

b)i) Deduce the expression for the optimum pressure for intercooling in a gas turbine cycle. (6)

ii) In a gas turbine plant, air is compressed through a pressure ratio of 6:1 from 15°C. It is then heated to the maximum permissible temperature of 750°C and expanded in two stages each of expansion ratio 6, the air being reheated between the stages to 750°C. A heat exchanger allows the heating of the compressed gases through 75 per cent of the maximum range possible. Calculate (i) The cycle efficiency (ii) The work ratio (iii) The work per kg of air. The isentropic efficiencies of the compressor and turbine are 0.8 and 0.85 respectively. (10)