Code No: RR221403 **Set No.1**

**II B.Tech. II Semester Regular Examinations, April/May -2005**
**THERMAL ENGINEERING AND HEAT TRANSFER**
**( Common to Mechatronics and Production Engineering)**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. (a) What do you mean by air standard cycles? What are the assumptions for air standard cycles?
   (b) Derive an equation for the air standard efficiency of an engine working on the Otto cycle in terms of its compression ratio and ratio of specific heats of air.
2. (a) Briefly describe the rating of CI engine fuels.
   (b) What are the required qualities of CI engine fuels?
3. (a) Compare the merits and demerits of air and water cooling systems.
   (b) Describe the effects of the following variables on the cylinder temperature:
      i. Air-fuel ratio
      ii. Engine power
      iii. Design of combustion chamber and material used.
4. The following observations are mode during a trial on an oil engine:
   (a) Motor Power to start the engine = 10kW
   (b) R.P.M = 1750
   (c) Brake Torque = 327.5Nm
   (d) Fuel used = 15kg/hr
   (e) Calorific value of fuel used = 42MJ/kg
   (f) Air supplied = 4.75kg/min
   (g) Quantity of cooling water = 16kg/min
   (h) Outlet temperature of cooling water = $65^oC$
   (i) Room temperature = $20^oC$
   (j) Exhaust gas temperature = $400^oC$
   Take $C_{pw} = 4.2kJ/kg.kandC_{pg} = 1.25kJ/kgk$ Determine
      i. B.P.
      ii. Mechanical efficiency
      iii. BSFC
      iv. Draw a heat balance sheet on kW basis and percentage basis.
5. (a) Compare the working process in reciprocating I.C. engines and gas turbines.

(b) Describe with neat sketches the working of a simple constant pressure open cycle gas turbine. How does the actual cycle differ from the theoretical cycle?

6. (a) State Fourier's law of one-dimensional heat conduction equation and obtain an expression for the thermal conductivity. Explain the significance of the minus sign associated with the statement of Fourier's law of heat conduction.

   (b) Calculate the heat loss in 5 hr through a glass pane 8 mm thick and $1m^2$ area if the two surfaces differ by $1.5^oC$ in temperature. Take k =0.82 W/mk.

7. (a) Calculate the Nusselt number for the following:
   L = 15 cm; k = 2.9 W/mk; $h = 45W/m^2C$.

   (b) During winter season the wind is blowing parallel to the short side of a flat roof at a speed of 75 km/hr. The size of roof is $9m \times 20m$ and the temperature of air is $-5^oC$ and that of roof surface is $5^oC$. Calculate the heat loss through the roof.

8. (a) What do you mean by 'total emissive power'? State Stefan-Boltzman Law and explain.

   (b) The concentric spheres, 20 cm and 30 cm in diameter are used to store liquid oxygen at $-153^0C$ in a room at $300^0K$. The space between spheres is evacuated. The surfaces of the spheres are highly polished as E = 0.04. Find the rate of evaporation of liquid oxygen as per hour. Take latent heat of oxygen as 209 kJ/kg.

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1. (a) With the help of p-V and T-s diagram explain Otto cycle clearly showing the process during which heat is supplied and rejected.
   (b) In a Carnot cycle, the maximum pressure and temperature of the cycle are 17.5 bar and $175^oC$. The isothermal expansion ratio is 2. Calculate the thermal efficiency, work done and mean effective pressure.
2. (a) Describe the important qualities of a CI engine fuel.
   (b) Briefly describe the rating of CI engine fuel.
3. (a) Why cooling of an I.C engine is necessary?
   (b) What are the various types of radiators? Is the name 'radiator' correct? Sketch the tube and fin arrangements in these radiators.
4. (a) Give a brief account of the injection in S.I. engine.
   (b) With sketches explain the possible locations of the injection nozzle in S.I. engines.
5. (a) Sketch a line diagram of a semi-closed gas turbine cycle. Indicate its place of operation.
   (b) Discuss the relative advantages and disadvantages of reciprocating I.C.engines and gas turbines.
6. Prove that the heat loss per square metre of outside surface area of a hollow sphere heated from within is equal to
   $q = \frac{2k(T_1 - T_2)}{(D_2 - D_1)\frac{D_2}{D_1}}$
   where $T_1$ *and* $T_2$ are the temperatures and $D_1$ *and* $D_2$ are the diameters of the inner and outer surfaces respectively.
7. The parallel outer and inner walls of a building are 4m high and 5m long. The walls are 10 cm apart. The inner surface of the inner wall is at $25^oC$ and the inner surface of the outer wall is at $5^oC$.
   (a) Calculate the total heat loss per hour.
   (b) If the air space is divided in half by a sheet of aluminium foil 0.025 mm thick parallel to the walls, what would be the heat loss per hour.
8. (a) Explain the difference between monochromatic emissive power and the total emissive power of a blank body.

(b) Determine the heat lost by radiation per meter length of a 8 cm diameter pipe at $300^0C$ if it is

i. located in a large room with red brick walls at a temperature of $27^0C$ and

ii. enclosed in a 16 cm diameter red brick conduit at a temperature of $27^0C$. Given emissivity of steel pipe as 0.79 and emissivity of brick conduit as 0.93.

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1. (a) Explain the difference between Otto cycle and Diesel cycle.
   (b) Derive an expression for the air standard efficiency of Diesel cycle. Show that efficiency of Diesel cycle is always lower than efficiency of Otto cycle for the same compression ratio.
2. Explain why a rich mixture is required for the following:
   (a) Idling
   (b) Maximum power
   (c) Sudden acceleration.
3. (a) What is supercharging? How is it achieved?
   (b) Describe with suitable sketches the following system of a carburetor.
4. (a) Explain the functions of a nozzle.
   (b) Explain the working of a fuel injector with the help of a neat sketch.
5. In a simple gas turbine plant air enters the compressor at 1 bar and $27^oC$ and leaves at 6 bar. It is then heated in the combustion chamber to $700^oC$ and then enters the turbine and expands to 1 bar. The isoentropic efficiency of compressor and turbine are 0.80 and 0.85 respectively and the combustion efficiency is 0.98. The fall in pressure through the combustion chamber is 0.1 bar. Determine
   (a) the thermal efficiency
   (b) the work ratio
   (c) the air rate in kg/kw
   (d) the specific fuel consumption and
   (e) the air-fuel ratio.
6. (a) Derive an expression for the overall coefficient of heat transfer based on the inside area for the composite cylinder having two layers with fluid boundaries.
   (b) A brick wall 25 cm thick is faced with concrete of 5 cm thick. The thermal conductivity of the brick is 0.7 W/mk while that of the concrete is 0.9 W/mk. If the temperature of the exposed brick face is $30^oC$ and that of the concrete is $5^oC$, find the heat loss per hour through a wall of $10 \times 5m$.
7. (a) Explain the difference between laminar and turbulent flow.

(b) Derive an equation for the film heat transfer coefficient in forced convection using dimensional analysis. What are its limitations.

8. (a) What do you mean by 'Gray surface'? Explain.

(b) d meters outer diameter sphere is located eccentrically in a D meters inner diameter sphere. Determine

i. the shape factor between outer sphere to inner sphere

ii. If the inner sphere diameter is 1 m and outer sphere diameter is 2 m then find the shape factor $F_{2-1}$

iii. If the temperature of the outer sphere is $300^0C$ and emissivity is 0.8 and the temperature of the inner sphere is $100^0C$ and emissivity is 0.6, for the same dimensions given in

iv. determine the heat transfer rate.

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Code No: RR221403 **Set No.4**

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**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
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1. (a) Explain the Dual cycle. Why this cycle is also called limited pressure cycle?
   (b) Derive an expression for air-standard efficiency of dual cycle in terms of compression ratio, explosion ratio and cut-off ratio.
2. Explain the following:
   (a) Rich mixture
   (b) Stoichiometric mixture
   (c) Lean mixture.
3. (a) Explain the principle of carburetion.
   (b) With a neat sketch explain the working of principle of a simple carburetor.
4. (a) What are the basic requirements of a good injection system.
   (b) Explain the importance of a fuel filter and draw a neat diagram of a filter used with oil injection system.
5. (a) Explain the advantages and disadvantages of gas turbine over I.C. engines.
   (b) In a gas turbine plant, operating on joule cycle, air is compressed from 1 bar and $15^o$ through a pressure ratio of 6. It is then heated to l000K in a combustion chamber and expanded back to a pressure of 1 a bar. Calculate the work done, cycle efficiency and work ratio. Assume isoentropic efficiencies of the turbine and compressor as 90% and 8.5% respectively.
6. (a) What is the basic difference between conduction and radiation heat transfer processes?
   (b) Identify the a modes of heat transfer in the following examples.
      i. A car disc brake during braking
      ii. A domestic boiler
      iii. Heating a room using an electric fan heater
      iv. Soldering an electric circuit board
      v. Gas welding two sheets of steel plate.
7. (a) Explain the difference between natural and forced convection.
   (b) State the Buckingham's Π-theorem. Using dimensional analysis obtain an expression for Nusselt number in terms of Reynolds and Prandtl numbers.

8. (a) Define the term 'Emissivity'. What are the factors on which emissivity of a substance depends?

   (b) Two parallel surfaces of emissivities 0.85 and 0.80 respectively 1m in diameter, are separated by a distance of 0.5m. If these two surfaces are connected non-conducting but reradiating surfaces, what is net radiation exchange between than if the temperatures are $1000^oC$ and $800^oC$. What would be the value of the direct radiation exchange between the two surfaces?

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