

II B.Tech II Semester Supplementary Examinations, Apr/May 2008
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

1. When an Otto cycle works between T_1 and T_3 then prove that the compression ratio for the maximum output per kg of working fluid is given by

$$R_c = \sqrt{(T_3/T_1)^{1/\gamma-1}} \text{ and}$$

The intermediate temperature of the working fluid is given by $T_2 = T_4 = \sqrt{T_1 \cdot T_3}$ [16]

2. What is the effect of high sulphur content on the performance of S1 and C1 engine? Discuss. [16]

3. (a) How lubricating oils are classified?
 (b) What is an air cooling system and in which type of engine it is normally used?
 (c) Why fins and baffles are required in an air-cooled engine? Explain. [4+6+6]

4. (a) List the parameters by which performance of an engine is evaluated.
 (b) What are the various methods for measurement of brake house power?[6+10]

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. [8+8]

6. A standard 5 cm steel pipe carrying steam is insulated with 7.5 cm layer of glass wool. The outer surface temperature of the pipe is 200°C and that of the covering is 65°C . Estimate the heat loss from pipe and assume the value of thermal conductivity of steel. [16]

7. A horizontal cylinder 2.5 cm diameter and 0.6m long is suspended in water at 20°C . Calculate the rate of heat transfer if the cylinder surface is at 55°C . What would be the rate of heat transfer is the cylinder is suspended in light oil at 55°C . The following properties at 37.5°C may be used:

	Water	Oil	
$\rho(\text{kg/m}^3)$	992	905	
$\mu(\text{kg/hrm})$	2.47	82.0	
$k(\text{W/mk})$	0.622	0.133	
$\beta(\text{k}^{-1})$	3.96×10^{-4}	7.2×10^{-4}	
P_r	4.64	324	[16]

8. (a) If a substance is opaque to light, is it also opaque to radiation of heat?

- (b) Two large parallel plates are spaced a small distance apart and maintain at respective temperatures of 1000°C and 500°C .
- Assuming that the plates behave as black bodies, what is the net radiative heat flux from the hotter to colder plate?
 - What is the value of this heat flux if the temperature of the cooler plate is increased to 700°C . [6+10]

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1. (a) Draw the Carnot cycle on $p - v$ and T-S diagram and explain.
(b) A C.I engine works an ideal Dual cycle whose compression ratio is 12. The pressure and temperature at the beginning of the cycle are 1 bar and 85°C. The maximum pressure of the cycle is limited to 55 bar and heat addition at constant pressure is 1/30 of the stroke. Find thermodynamic efficiency of the cycle. [8+8]
2. What are the different kinds of fuels used in an IC engine? Discuss them in detail. [16]
3. (a) What do you mean by 'Timed injection system'? Explain.
(b) Describe with a sketch any petrol injection system. [6+10]
4. (a) Explain the functions of a nozzle.
(b) Explain the working of a fuel injector with the help of a neat sketch. [4+12]
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. [8+8]
6. (a) What are different modes of heat transfer? Discuss the mechanism of conduction heat transfer in solids.
(b) Identify the various modes of heat transfer in the following cases.
 - i. Heat transfer from an auto radiator
 - ii. Condensation of steam in condenser
 - iii. Heat loss from a thermos flask
 - iv. Protection of human body with warm clothing in winter. [8+8]
7. (a) Calculate the appropriate Grashof numbers. State whether the flow is laminar or turbulent for the following case.
A central heating radiator, 0.6m high with a surface temperature of 75°C in a room at 18°C ($\rho = 1.2 \text{ kg/m}^3$, $\text{Pr} = 0.72$ and $\mu = 1.8 \times 10^{-5} \text{ kg/ms}$).
(b) An airplane wing is 1.2m wide and its surface is at 24°C. The aeroplane is flying at 240 km/hr in air at 0°C and 67 cm Hg pressure. Calculate the heat loss per metre length of the wing. [8+8]

8. (a) What do you mean by 'Gray surface'? Explain.
- (b) d meters outer diameter is located eccentrically in a D meters inner diameter sphere. Determine
- the shape factor between outer sphere to inner sphere
 - If the inner sphere diameter is 1 m and outer sphere diameter is 2 m then find the shape factor F_{2-1}
 - If the temperature of the outer sphere is 300°C and emissivity is 0.8 and the temperature of the inner sphere is 100°C and emissivity is 0.6, for the same dimensions given in
 - determine the heat transfer rate. [6+10]

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1. (a) How the I.C. Engines are classified?
(b) With neat sketches, explain the working of four strokes C.I. Engine. [6+10]
2. Explain why a rich mixture is required for the following:
(a) Idling
(b) Maximum power
(c) Sudden acceleration [5+5+6]
3. (a) What are the various characteristics of an efficient cooling systems?
(b) Explain with the help of sketches
 - i. Thermosyphon cooling system:
 - ii. Pressure cooling system. [6+10]
4. (a) Distinguish between the power and specific output.
(b) Why Morse test is not suitable for single cylinder engine. Describe the method of finding friction power using Morse test. [4+12]
5. A turbo jet unit flying at a speed of 750 km/hr at an altitude where air temperature and pressure are 22 K and 0.877 bars. The maximum temperature of the plant is limited to 860°C. Find the specific thrust produced if the exhaust gases from the turbine are expanded to atmospheric pressure in a convergent nozzle.
Use the following data : pressure ratio of the compressor = 4:1
Efficiency of the ram compression = 90%, $\zeta_e = 80\%$, $\zeta_f = 85\%$, $\zeta_n = 93\%$, Transmission efficiency = 98%. Neglect the pressure losses and mass of the fuel and find the specific thrust produced by the unit. [16]
6. A standard 5 cm steel pipe carrying steam is insulated with 7.5 cm layer of glass wool. The outer surface temperature of the pipe is 200°C and that of the covering is 65°C. Estimate the heat loss from pipe and assume the value of thermal conductivity of steel. [16]
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- (b) An airplane wing is 1.2m wide and its surface is at 24°C . The aeroplane is flying at 240 km/hr in air at 0°C and 67 cm Hg pressure. Calculate the heat loss per metre length of the wing. [8+8]
8. (a) When a body is said to be black? What is the range of wave lengths it absorbs?
- (b) Compute the radiant energy loss from 1 cm diameter opening in a thin walled furnace located in a large enclosure, if the temperature within the furnace is 900°C and the surroundings are at 20°C . [6+10]

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1. (a) How the I.C. Engines are classified?
(b) With neat sketches, explain the working of four strokes C.I. Engine. [6+10]
2. (a) Describe the important qualities of a CI engine fuel.
(b) Briefly describe the rating of CI engine fuel. [8+8]
3. (a) Explain the principle of carburetion.
(b) With a neat sketch explain the working of principle of a simple carburettor. [6+10]
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. [6+10]
5. (a) What are the relative advantages and disadvantages of closed cycle and open cycle gas turbine.
(b) Find the output of a gas turbine per kg of air flow per second and cycle efficiency when pressure ratio is 4:1. Isoentropic efficiency of turbine and compressor is 0.9 and 0.8 respectively. Calorific value of fuel used is 42 MJ/kg. Air fuel ratio used is 120:1, take $C_p = 1.05 \text{ kJ/kg K}$, $\nu = 1.4$ and inlet air temperature is 26°C . [8+8]
6. (a) Identify the mode of heat transfer in the following examples.
 - i. Coffee in a vacuum flask
 - ii. A domestic boiler
 - iii. Disc brake of a car during braking
(b) The wall of a house 7m wide and 6 m high is made from 0.3 m thick brick with a thermal conductivity of 0.6 W/mk . The surface temperature on the inside of the wall is 16°C and that as the outside is 6°C . Find the heat flux through the wall and the total heat loss through it. [8+8]
7. (a) A gas flow ($Pr = 0.71$, $\mu = 4.63 \times 10^{-5} \text{ kg/ms}$ and $C_p = 1175 \text{ J/kg k}$) over a turbine blade of chord length 20 mm where the average heat transfer coefficient is $1000 \text{ W/m}^2\text{k}$. Calculate the Nusselt number.
(b) Calculate the heat transfer coefficient for water flowing through a 2 cm diameter tube with a velocity of 2.5 m/s . The average temperature of the water is

50°C and surface temperature of the tube is slightly below this temperature. Assume the flow to be turbulent. The properties at 50°C are given below:

$$\begin{aligned} C_p &= 4182 \text{ J/kg K}, & K &= 0.643 \text{ W/mK} \\ \rho &= 988 \text{ kg/m}^3, & \mu &= 544 \times 10^{-6} \text{ kg/ms}. \end{aligned} \quad [6+10]$$

8. (a) State and explain Wien's law or radiation?
- (b) Prove that the emissivity factor F_{1-2} for two concentric spheres is $\frac{1}{\frac{1}{E_1} + \left(\frac{r_1}{r_2}\right)^2 \left(\frac{1}{E_2} - 1\right)}$. It is given that total emissivities of the two spheres are E_1 and E_2 the outer radius of the inner sphere is r_1 and the inside radius of the outer sphere is r_2 . [10+6]
