Code No: R05220304 **Set No. 1**

II B.Tech II Semester Regular Examinations, Apr/May 2007
THERMAL ENGINEERING-I
(Common to Mechanical Engineering and Automobile Engineering)
Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Draw the neat sketch of fuel pump for C.I Engine? Explain.
   (b) Explain the ideal and actual port timing diagrams of a 2-stroke S.I engine. [8+8]

2. (a) How the antiknock additives prevent detonation in S.I. Engine? What are different additives used in S.I. Engine?
   (b) What are homogeneous and heterogeneous mixtures? In which engines these mixtures are used? Explain. [8+8]

3. (a) Explain different types of direct injection type combustion chambers with suitable diagrams.
   (b) Describe the phenomenon of knocking in C.I.Engine and explain the methods to minimize knocking. [8+8]

4. In a test of a four-cylinder, four-stroke petrol engine of 75 mm bore and 100 mm stroke, the following results were obtained at full throttle at a constant speed and with a fixed setting of the fuel supply of 0.082 kg/min.
   bp with all cylinders working = 15.24 kW
   bp with cylinder number 1 cut-off = 10.45 kW
   bp with cylinder number 2 cut-off = 10.38 kW
   bp with cylinder number 3 cut-off = 10.23 kW
   bp with cylinder number 4 cut-off = 10.45 kW
   Estimate the indicated power of the engine under these conditions. If the calorific value of the fuel is 44 MJ/kg, find the indicated thermal efficiency of the engine. Compare this with the air-standard efficiency, the clearance volume of one cylinder being 115 cc. [16]

5. The average indicator and information taken from a 25 × 35 cm, single cylinder, double- acting reciprocating air compressor operating at 80 r.p.m. is
   Head end area = 11.1 cm^2, Crank end area = 12.9 cm^2, Length = 7.5 cm, Spring scale = 2.5 bar per cm of deflection. Account for the 5 cm dia piston rod and find
   (a) then mean effective pressure and the indicated power for each end ;
   (b) the total indicated power : [16]

6. A helicopter gas turbine requires an overall pressure ratio of 10 : 1. This is to be obtained using a two-spool layout consisting of a four-stage axial flow compressor followed by a single-stage centrifugal compressor. The polytropic efficiency of the

axial flow compressor is 92 percent and that of the centrifugal is 83 percent. The axial compressor has stage temperature rise of 30^0 C, using symmetrical stages with a stator outlet angle of 20^0. If the mean diameter of each stage is 250 mm and each stage is identical, calculate the required rotational speed. Assume a work done factor of 0.86 and a constant axial velocity of 150 m/s. Assuming an axial inlet at the eye of the impeller, an impeller diameter of 330 mm, a slip factor of 0.90 and a power input factor of 1.04, calculate the rotational speed required for centrifugal compressor. Ambient conditions are 1.01 bar and 288 K. [16]

7. (a) Describe, in detail, the desirable chemical properties of a refrigerant.
   (b) Classify refrigerants based on safety criteria giving three examples of each.
   (c) Write desirable properties of ammonia as a refrigerant. [16]

8. (a) What is effective temperature ?
   (b) In a heating application, moist air enters a steam heating coil at 10^0 C, 50% RH and leaves at 30^0C. Determine the sensible heat transfer if mass flow rate of air is 100 kg of dry air /s. Also determine the steam mass flow rate if steam enters saturated at 100^0 C and condensate leaves at 80^0 C. [16]

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Code No: R05220304 **Set No. 2**

II B.Tech II Semester Regular Examinations, Apr/May 2007
THERMAL ENGINEERING-I
(Common to Mechanical Engineering and Automobile Engineering)
Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Is the effect of compression ratio on efficiency as same in fuel-air also? Explain.
   (b) Explain with the help of p-v diagram the loss due to variation of specific heats in Otto cycle? [8+8]
2. (a) What are generally faced problems in S.I. Engine combustion chamber? Identify the suggestions to rectify the problems.
   (b) What are different auxiliary components required in S.I. Engine for achieving better combustion. [8+8]
3. (a) What are different stages of combustion in C.I. Engine? Explain with p - θ diagram.
   (b) What is diesel knock? How to minimize knocking in C.I. Engine. [8+8]
4. (a) What is the purpose of engine testing.
   (b) The following date was recorded during testing of a four stroke cycle gas engine. Area of indicator diagram = 900 mm^2; Length of indicator diagram = 70 mm; spring scale = 0.3 bar/mm; Diameter of piston = 200 mm; Length of stroke = 250 mm; Speed = 300 rpm. Determine
      i. Indicated mean effective pressure
      ii. Indicated power. [6+10]
5. (a) Explain the following as referred to air compressors :
      i. Isothermal efficiency
      ii. Volumetric efficiency
   (b) Prove the following relationship :
   $$\eta_{vol}(ambient) = \frac{p_{1\times}\, Tambient}{p_{ambient}\times T_1}\left(1 + C - C\left(\frac{p_2}{p_1}\right)^{1/n}\right)$$ [16]
6. A single-sided straight vaned centrifugal compressor is required to deliver 10 kg of air per sec with a total pressure ratio of 4 : 1 when operating at a speed of 16,500 r.p.m. The air inlet pressure and temperature are 1.013 bar and 300 K. Calculate:
   (a) Actual rise in stagnation temperature
   (b) Tip speed of the impeller
   (c) Tip diameter
   (d) Inlet eye annulus area and

(e) Theoretical power required to drive the compressor.

Take $\sigma = 0.94$, $\eta_c = 80$ percent, $c_p = 1.005$ kJ/kg K, $\gamma = 1.4$, The air enters the eye axially with a velocity of 150 m/s. [16]

7. (a) Moist air exists at total pressure of 0.01325 bars and 25^0C dry bulb temperature. If the degree of saturation is 50%, using steam-tables determine Specific humidity, Dew- point temperature and Specific volume of moist air.

   (b) What is 'wet bulb temperature'? How is it measured ? Standing with final expression for 'wet bulb temperature' and 'thermodynamic wet bulb temperature', determine the condition for which these two are equal. [16]

8. Room air at 26^0C DBT and 50% RH is mixed with outdoor air at 43^0C dBT and 40% RH in the ratio of 4 : 1. The mixture is passed through a cooling coil maintained at 5^0C with a BF of 0.15. The air from the cooling coil is mixed with room air in the ratio of 4 : 1. The mixture is then reheated to 20^0C DBT and supplied to the conditioned space.

   (a) Show the flow diagram schematically

   (b) Show the different processes on a psychrometric chart.

   (c) For 450 kg of supply air per minute, determine the quantity of fresh air needed, the refrigeration load and the heat supplied to the reheater coil. [16]

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Code No: R05220304 **Set No. 3**

II B.Tech II Semester Regular Examinations, Apr/May 2007
THERMAL ENGINEERING-I
(Common to Mechanical Engineering and Automobile Engineering)
Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Briefly explain the operation of a piston controlled two stroke S.I. engine?
   (b) What is p-v diagram of an I.C. Engine? What is its importance? [8+8]

2. (a) Describe the mixture requirement in S.I. Engine for different speed conditions. How to achieve above requirements from the carburetor.
   (b) What are different types of combustion chambers used in S.I.Engine? [10+6]

3. (a) What is the difference between physical delay and chemical delay? Explain its importance.
   (b) Explain the working principle of pre-combustion chamber with the suitable diagram. [8+8]

4. (a) List the parameters by which performance of an engine is evaluated.
   (b) Find the bore of the single-cylinder diesel engine working on the four-stroke cycle and delivers 40 kW at 200 rpm from the following date:
   Compression ratio : 14:1
   Fuel cut-off : 5% of stroke
   Index of compression curve : 1.4
   Index for expansion curve : 1.3
   Pressure at beginning of compression : 1 atm
   Ratio of stroke to bore : 1.5 to 1. [8+8]

5. A single stage, single acting air compressor 30 cm bore and 40 cm stroke runs at 200 r.p.m. The suction pressure is 1 bar at 15^0C and the delivery pressure 5 bar. Determine the indicated mean effective pressure and the ideal power required to run it, when
   (a) compression is isothermal,
   (b) compression follows the law $pv^{1.25}$= C,
   (c) compression is reversible adiabatic ($\gamma = 1.4$), and
   (d) compression is irreversible adiabatic (n = 1.5)

   Neglect clearance, Determine the isothermal efficiency for (b), (c) and (d). Also find adiabatic efficiency for (d). Assume isentropic or reversible adiabatic index as, $\gamma = 1.4$ and R = 0.287 kJ / kg^0K. [16]

6. A single-sided centrifugal compressor is to deliver 15 kg of air per second when operating at a pressure ratio of 4 : 1 and a speed 12,000 r.p.m. The inlet stagnation conditions may be taken as 288 K and 100 K pa. Assuming a slip factor of 0.9, a power and input factor of 1.04 and an isentropic efficiency of 80%, estimate the overall diameter of the impeller. If the Mach number is not to exceed unity at the impeller tip, and 50% of the losses are assumed to occur in the impeller, find the minimum possible depth of the diffuser. [16]

7. (a) State five of the most important properties of a good refrigerant.
   (b) An aircraft refrigeration plant has to handle a cabine load of 30 tons. The atmospheric temperature is 17^0C. Atmospheric air is compressed to a pressure of 0.95 bar and temperature of 30^0C due to ram action. This air is then further compressed in a compressor to 4.75 bars, cooled in a heat exchanger to 67^0 C, expanded in a turbine to 1 bar pressure and supplied to the cabin. Air leaves the cabin at a temperature of 27^0 C. The isentropic efficiencies of both compressor and turbine are 0.9. Calculate the mass of air circulated per minute and the COP. For air C_p = 1.00 kJ/kg K and C_p / C_v= 1.4. [16]

8. The following data is given for the space to be air conditioned :

Inside design conditions maintained :	$\begin{cases} 25^0 C\ DBT \\ 50\% RH \end{cases}$
Outside air conditions :	$\begin{cases} 43^0 C\ DBT \\ 27^0 WBT \end{cases}$
Room sensible heat gain :	40 kW
Room latent heat gain:	10 kW
By-pass factor of cooling coil used :	0.2

The return air from the room is mixed with outside air before entry to cooling coil in the ratio of 3 : 1 by mass

   (a) determine :
      i. ADP of cooling coil
      ii. Entry and exit conditions of air for cooling coil
      iii. Dehumidified air quantity
      iv. Fresh air mass flow rate and volume flow rate
      v. Refrigeration load on the cooling coil (cooling plant)
   (b) How will the results get modified if all fresh air is supplied through the cooling coil to offset the room loads. [16]

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Code No: R05220304 **Set No. 4**

II B.Tech II Semester Regular Examinations, Apr/May 2007
THERMAL ENGINEERING-I
(Common to Mechanical Engineering and Automobile Engineering)
Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What is valve overlap in four stroke engine? Why it is provided?
   (b) Explain the principle of scavenging and its importance? [8+8]

2. (a) What are different ill effects of knocking and suggest the methods to minimize knocking.
   (b) Draw the theoretical p - θ diagram of S.I.Engine combustion in comparison with actual p - θ diagram. [8+8]

3. (a) What is the difference between physical delay and chemical delay? Explain its importance.
   (b) Explain the working principle of pre-combustion chamber with the suitable diagram. [8+8]

4. (a) List the parameters by which performance of an engine is evaluated.
   (b) Find the bore of the single-cylinder diesel engine working on the four-stroke cycle and delivers 40 kW at 200 rpm from the following date:
   Compression ratio : 14:1
   Fuel cut-off : 5% of stroke
   Index of compression curve : 1.4
   Index for expansion curve : 1.3
   Pressure at beginning of compression : 1 atm
   Ratio of stroke to bore : 1.5 to 1. [8+8]

5. (a) What is the influence of intake temperature, intake pressure, clearance and compression and expansion indices on the performance of reciprocating air compressor.
   (b) Prove that the Heat Rejected per kg of air in reciprocating air compressor with perfect intercooling is
   $q\,(Rejected) = \left(C_p + \frac{C_v(\gamma - n)}{n-1}\right)(T_2 - T_1)$ [16]

6. (a) What is surging in axial-flow compressors ? What are its effects ? Describe briefly
   (b) What is stalling in an axial compressor stage ? How is it developed ?
   (c) What is rotating stall ? Explain briefly the development of small and large stall cells in an axial compressor stage. [16]

7. In an aqua-ammonia absorption refrigeration system, the environment temperature is 35^0C and refrigerator temperature is - 5^0C. Designing range is 0.08. Find
   (a) Mass of strong solution handled by the pump per kg of NH_3.
   (b) Exergetic efficiency. [16]

8. (a) What are the different methods used in the design of air-conditioning ducts ? Explain any one method in detail.
   (b) A central air-conditioning plant is to be installed for cooling an office complex during the summer season. Give a layout of the plant and explain the various processes on a psychometric chart. [16]

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