Code No: RR220801 **Set No. 1**

II B.Tech II Semester Regular Examinations, Apr/May 2006
MECHANICAL ENGINEERING
(Chemical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. 2.5 m^3 of hydrogen at a pressure of 1 bar and 25^0C is compressed isentropically to 4 bar. The same gas is expanded isothermally to the original volume. Finally, the gas pressure is restored to the original volume by a constant volume heat rejection process. Determine
   (a) pressure, volume and temperature at each end of operation,
   (b) the heat added during the isothermal process,
   (c) the heat rejected during constant volume process and
   (d) change in internal energy during each process.

   Assume R = 4.206 kJ/kgK and C_p = 14.25 kJ/kgK. [16]

2. (a) Draw neatly the sequences of operation of Carnot engine on p-v and T-s diagrams. Show that the entropy change during the cycle is zero
   (b) Two kg of superheated steam at 400^0C and 600 kPa is cooled at constant pressure by transferring heat from a cylinder until the steam is completely condensed. The surroundings are at 25^0C . Determine the net entropy change of the universe due to this process. [8+8]

3. A diesel engine has a 0.6 X 1.2 m bore and stroke and operates with 5 percent clearance. For a power output of 5000 hp, calculate the compression ratio and the rate of heat input if the cutoff ratio is 2.5. [16]

4. (a) State how the boilers are classified.
   (b) One kg of steam having a volume of 180 liters at a pressure of 800 kN/m^2abs expands to a volume of 240 liters. Find the final pressure and change in internal energy if it expands isothermally. [6+10]

5. (a) What are the advantages and disadvantages of closed cycle gas turbines?
   (b) The mean effective pressure of a single cylinder, two stroke cycle engine is 600kN/m^2. The bore and stroke of the engine are 11 cm and 14 cm respectively. If the engine is running at 1000 rpm, determine the IHP developed by the engine. [6+10]

6. (a) Explain the working of a single acting compressor with a neat sketch showing all basic components.

(b) A single acting compressor has zero clearance, stroke of 20cm and piston diameter 15cm. When the compressor is operating at 235rpm and compressing air from 10N/cm^2, 25^{o}C to 41N/cm^2, find

i. the volume rate of air handled and

ii. the ideal power required. [8+8]

7. (a) State the advantages and disadvantages of belt drive.

(b) An open belt drive connects two pulleys 1.2m and 0.5m diameter, on parallel shafts 3.6 m apart. The belt has a mass of 0.9kg/m length and the maximum tension in it is not to exceed 2kN. The larger pulley runs at 200 rpm. Calculate the torque on each of the two shafts and the power transmitted. Take $\mu = 0.3$. [6+10]

8. (a) With the help of neat sketch, explain a simple train of gear wheels for the same direction of rotation.

(b) Select appropriate type of rolling contract bearing under the following condition of loading and explain the reasons for the choice.

i. Light radial load with high rotational speed

ii. Axial thrust only with medium speed [6+10]

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1. (a) State the first law of thermodynamics and prove that for non-flow process, it leads to the energy equation $Q = W + \Delta U$.
   (b) Explain the following terms related to the thermodynamic concept:
      i. System
      ii. Surroundings
      iii. Boundary of a system [10+6]

2. (a) State and prove Clausius inequality and hence deduce that the property entropy exists.
   (b) Five hundred grams of gas at 3.5kgf/cm^2 abs and 30^{0}C are heated at constant volume until its pressure is 20kgf/cm^2 abs. The gas is then expanded at constant temperature until its volume is 1 m^3 . Determine the change of entropy for the whole system. Assume c_p as 0.25 kcal/kgK and c_v as 0.18 kcal/kgK. [8+8]

3. An air standard cycle operates in a piston cylinder arrangement with the following four processes: 1-2: isentropic compression from 100 kPa and15^0 C to 2 MPa; 2-3: constant pressure heat addition to 1200^{0}C ; 3-4: isentropic expansion; and 4-1: constant volume heat rejection.
   (a) Show the cycle on P-v and T-s diagrams
   (b) calculate the heat addition and
   (c) calculate the cycle efficiency. [16]

4. (a) What are the different methods of compounding of steam turbine stages? Describe any one method briefly.
   (b) A power plant operating on an ideal Rankin cycle has steam exiting the turbine at 500^{0}C and 2 MPa. If the steam enters the pump at 10 kPa, calculate
      i. the thermal efficiency with pump work included,
      ii. the thermal efficiency neglecting pump work, and
      iii. the percentage error in efficiency neglecting pump work [8+8]

5. (a) Explain the working of two stroke petrol engine giving neat sketches. In what respect it differs from two stroke diesel engine?
   (b) The indicated power of a four stroke cycle petrol engine is 38 kW. The stroke is 300 mm and the diameter is 200 mm. If the engine makes 450 explosions per minute, find the mean effective pressure. [10+6]

6. (a) Describe with a neat sketch the working of a single acting, single stage compressor.

   (b) A reciprocating compressor is to deliver 20 kg/min of air at 1600 kPa. It receives atmospheric air at 20^0C. Calculate the required power if the compressor is assumed to be 90 percent efficient. No cooling is assumed. [8+8]

7. (a) Explain the relative advantages and disadvantages of flat belt drive over V belt drive.

   (b) An impregnated belt 10mm $\times$ 250mm drives a pulley 100cm in diameter at 340 rpm. The angle contact on the smaller pulley is 120^0. The stress in the tight side is 1000 kN/m^2. Density of the belt is 0.98 g/cm^3. The coefficient of friction between the belt and the pulley is 0.35. Determine the power capacity of the belt in kW. [6+10]

8. (a) What do you understand by 'gear train'? Discuss the various types of gear trains.

   (b) Explain the principle, advantages and disadvantages of slipper bearings. [10+6]

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Code No: RR220801 **Set No. 3**

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

Answer any FIVE Questions
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1. A cylinder closed at both contains a free piston. On one side of which is nitrogen and other side is air. The initial pressure and volume of each is being 1.03 bar and 0.5 m^3 respectively. Both the piston and cylinder are perfectly insulated. In the cylinder on the air side of the piston there is an electric heater which is used to heat the air. Heat is added to the air in this manner until the volume occupied by the nitrogen is 0.3 m^3. The initial temperature of each gas is 50°C . Determine
   (a) the final temperature of air and
   (b) the heat supplied to air.

   Assume Cp for air as 1.005 and R for air as 0.287 kJ/kgK and $\gamma = 1.4$ for nitrogen. Also draw the PV diagram. [16]

2. (a) A heat pump is to maintain a house at 20^0C when the outside air is at -25^0C . It is determined that 1800 kJ is required each minute to accomplish this. Calculate the minimum horsepower required.
   (b) The temperature of a quantity of a gas is increased from 27^0Cto 147^0C at constant volume and the increase in entropy during the time is 1.5 kcal/K. Then there is again an increase in entropy of 1.7 kcal/K at constant pressure. Find the final temperature. Assume c_v =0.17 kcal/kgK. [8+8]

3. (a) Prove that the efficiency of an Otto cycle depends upon its compression ratio.
   (b) A spark ignition engine operates on an Otto cycle with a compression ratio of 9 and temperature limits of 30^0C and 1000^0C . If the power output is 500kW, calculate the thermal efficiency and the mass flux of air. [8+8]

4. (a) What are the different methods of compounding of steam turbine stages? Describe any one method briefly.
   (b) A power plant operating on an ideal Rankin cycle has steam exiting the turbine at 500^0C and 2 MPa. If the steam enters the pump at 10 kPa, calculate
      i. the thermal efficiency with pump work included,
      ii. the thermal efficiency neglecting pump work, and
      iii. the percentage error in efficiency neglecting pump work [8+8]

5. (a) What do you understand by four stroke cycle and two stroke cycle engine?
   (b) A four stroke cycle petrol engine has a stroke volume of 5.7 litres. Its mean effective pressure is 600 kN/$m^2$and rpm is 800. Find the indicated power of the engine. [6+10]

6. (a) Explain the working of a single acting compressor with a neat sketch showing all basic components.

   (b) A single acting compressor has zero clearance, stroke of 20cm and piston diameter 15cm. When the compressor is operating at 235rpm and compressing air from 10N/cm^2, 25^{o}C to 41N/cm^2, find

      i. the volume rate of air handled and

      ii. the ideal power required. [8+8]

7. (a) Explain the different methods by which power from one shaft to another is transmitted.

   (b) A belt embraces the shorter pulley 165^0 and runs over at a speed of 1700 m/min. Dimensions of the belt are: width = 20cm, thickness = 10mm, density is 1 g/cm^3. Determine the maximum power that can be transmitted at the above speed if maximum permissible stress in the belt is not to exceed 20 bar, $\mu = 0.3$. [8+8]

8. (a) Explain the hydrodynamic theory of lubrication

   (b) A compound gear train consists of 6 gears A,B,C,D,E and F and they have 20,30,40,50,60,70 teeth respectively, A is fitted to the first shaft and B is mashed with C. Gear D and E are fitted to the third shaft and E is meshed with F which is fixed to another shaft. If A rotates at 210 rpm, find the rpm of F. [6+10]

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1. (a) Define work, energy, and power. List the different units used for measuring work, energy and power.
   (b) What is meant by property? Enumerate the differences between intensive and extensive properties. [8+8]

2. (a) Ten kg of gas at 100^0C is heated until its temperature becomes 217^0C . Find the change of entropy when it is heated at
      i. constant pressure,
      ii. constant volume. Take c_p =0.24 kcal/kgK, c_v =0.17 kcal/kgK.
   (b) A Carnot engines operate in series between two reservoirs maintained at 280°C and 35^0C , respectively. The energy rejected by the first engine is input into the second engine. If the first engines efficiency is 20 percent greater than the second engines efficiency, calculate the intermediate temperature. [8+8]

3. (a) In what respect diesel cycle differs from Otto cycle. Which cycle gives higher efficiency for the same compression ratio?
   (b) The maximum allowable pressure in an Otto cycle is 8 MPa. Conditions at the beginning of the air compression are 85kPa and 22^0C . Calculate the required heat addition and the MEP, if the compression ratio is 8. [6+10]

4. A small stem power plant works on basic Rankin cycle. The steam supplied to the turbine is at 1000 kN/m^2 and400^0C . The steam is condensed in the condenser where the pressure maintained is 10 kN/m^2. Neglecting the pump work, determine the Rankin efficiency of the cycle. Also, find the generating capacity if the steam flow is 100 kg/min through the turbine. [16]

5. (a) Describe the major classifications of internal combustion engine.
   (b) A four stroke cycle internal combustion engine has a piston diameter of 150 mm and the average piston speed is 200 m per min. If the mean effective pressure is 700kN/m^2, find the indicated power of the engine. [8+8]

6. (a) Describe a reciprocating air compressor with a neat sketch.
   (b) A single stage air compressor receives air at 100 kN/m^2 abs and 27^0C and delivers it to 650 kN/m^2 abs. The compression follows the law $pv^{1.2}$ =constant and the clearance volume is 5 percent of the stroke volume. Calculate the volumetric efficiency. [8+8]

7. (a) Enumerate the advantages and disadvantages of chain drive over belt drive.

(b) A flat belt is required to transmit 35kW from a pulley of 1.5m effective diameter running at 300rpm. The angle of contact is spread over 11/24 of the circumference and the coefficient of friction between belt and pulley surface is 0.3. Determine, taking centrifugal tension into account, width of the belt required. It is given that belt thickness is 9.5mm, density of its material is 1.1 Mg.m^3 and the related permissible working stress is 2.5N/mm^2. [6+10]

8. (a) Explain the following terms used in gears:
   i. Circular pitch
   ii. Module
   iii. Addendum
   iv. Pressure angle

   (b) What are antifriction bearings? Discuss their classification. [8+8]

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