Elements of Mechanical Engineering
(ME-101, May.2007)

Time: 3 Hours Max. Marks: 60

Note: Question No. 1 is compulsory. Attempt five questions from section A and B, taking at least two questions from each section.

Section-A

1. (a) Define enthalpy.
   (b) How is the property of system classified? Explain with example.
   (c) What are the limitations of first law of thermodynamics?
   (d) How second law of thermodynamics overcomes the limitation of first law?
   (e) State and write the steady flow energy equation.
   (f) State the basic assumption in air standard cycle.
   (g) Draw Brayton cycle on P-V and T-S charts.
   (h) Differentiate between machine and mechanism.
   (i) Draw differential pulley lock.
   (j) Draw stress strain curve for a typical brittle material.

Section-B

2. (a) The vessel containing $0.8m^3$ of gas is compressed by doing 160 KJ of work. The variation in pressure (bar) follows $p = 7 - 3v$ (m^3). Determine final volume and pressure.
   (b) Convert the following when barometer reads 760 mm Hg
   $400\ KN/m^3$ Absolute to KN/m^2 gauge
   50 m Hg vacuum to m Hg and KN/m^2 absolute
   3.1 bar to KN/m^2
   $60\ KN/m^2$ to mm Hg vacuum
3. The following data pertaining to a steam power plant are given for each state corresponding to the figure shown below. Determine heat transfer in each process and turbine work.

State	1	2	3	4
Pressure(MPa)	2.0	1.9	15	14
Enthalpy(KJ/Kg)	3020	3000	2300	200

Fig.

4. A quantity of air at 1 bar and 7ºC is heated at constant volume in a cylinder until its temperature has risen to 827ºC. After this it is expanded isentropically until the pressure falls to 1 bar following which heat is rejected at constant pressure until the temperature is again equal to 7ºC.
   Determine, per kg of air.
   a. The pressure, volume and temperature at the end of each of the operations.
   b. The heat input to the cycle
   c. Work output of the cycle
   d. Efficiency of the cycle

   A perfect gas flows steadily through a horizontal cooler. The mass flow rate is 1 kg/s. The pressure and temperature are 2 bar and 400 K at entry and 1.5 bar and 280 K at exit respectively. The cross sectional areas at entry and exit are each $0.01m^2$. Using the data given below determine.
   (a) the velocities at the entry and exit and
   (b) the heat transfer rate from the gas
   $C_V = 0.161$ KJ/kg K
   R = 0.2 KJ/kg K
5. Cold storage plant requires 6330 KJ/kg (30 tonnes) of refrigerant. Determine power required for the following conditions
   Evaporator temperature = -20ºC
   Ambient temperature = 30ºC
   $(COP)_{ref}$ = 25% of ideal cycle COP

Section-C

6. (a) Explain the working of two stroke IC engine with neat sketches.
   (b) Derive the expression for the air standard efficiency for otto cycle.
7. (a) Explain the working of elliptical trammel.
   (b) A weight of 48 N is to be raised by means of a wheel and axle. The axle is 100 mm diameter and wheel is 400mm diameter. If the force of 16 N has to be applied to the wheel, find;
   (i) Mechanical advantage
   (ii) Velocity ratio
   (iii) Efficiency of the machine
8. (a) Define the following
   a. Hardness

b. Ductility
c. Resilience
d. Poisson's ratio
e. Bulk modulus
f. Shear stress

(b) Derive the relation between elastic constants

9. (a) What do you understand by slider crank mechanism? Explain its working with neat sketch.
(b) Write a note on mechanical behaviour of engineering material.