

**2010**  
**MECHANICAL ENGINEERING**

**Paper 1**

*Time : 3 Hours ]*

*[ Maximum Marks : 300*

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**INSTRUCTIONS**

*Candidates should attempt **all** the questions in Parts A, B & C. However, they have to choose only **three** questions in Part D.*

*Answers must be written in the medium opted (i.e. English or Kannada).*

*This paper has four parts :*

- |          |           |
|----------|-----------|
| <b>A</b> | 20 marks  |
| <b>B</b> | 100 marks |
| <b>C</b> | 90 marks  |
| <b>D</b> | 90 marks  |

*Marks allotted to each question are indicated in each part.*

**SEAL**

[Turn over

**PART A**

4×5=20

*Answer each of the following questions in about 50 words. Each question carries 5 marks.*

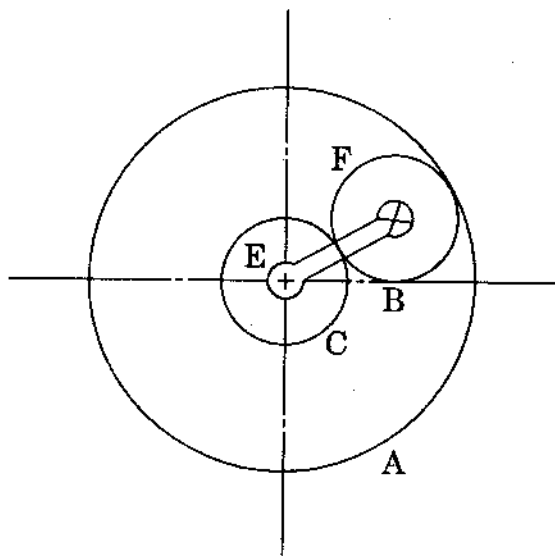
1. (a) What is meant by Virtual work ? 5
- (b) What is a structure and what is the difference between a machine and a structure ? 5
- (c) What are the different types of followers ? Classify them according to the motion of follower, location of axis of the follower and according to the shape of that part which is in contact with the cam. 5
- (d) What is the difference between brakes and dynamometers ? What are the different types of Mechanical brakes ? 5

**PART B**

10×10=100

Answer all the following questions. Each question carries 10 marks.  
Answers for theory questions are not to exceed about 100 words each.

2. The maximum and minimum speed of a flywheel are 242 r.p.m. and 238 r.p.m. respectively. The mass of flywheel is 2600 kg and radius of gyration is 1.8 m. 10  
Find  
(i) Mean speed of flywheel  
(ii) Maximum fluctuation of energy and  
(iii) Co-efficient of fluctuation of speed.
3. An epicyclic gear consists of three wheels A, B and C as shown in the figure. Wheel A has 72 internal teeth, C has 32 external teeth. The wheel B gears with both A and C and is carried on an arm which rotates about the centre of A at 18 r.p.m. If the wheel A is fixed, determine the speed of wheels B and C. 10



4. A transmission shaft, rotating at 500 r.p.m., drives a milling machine which requires 3.75 kW at 750 r.p.m. A 300 mm diameter cast iron pulley is mounted on the transmission shaft. A preliminary design proposes using a belt 4.75 mm thick, which has a density of  $970.001 \text{ kg/m}^3$ . The Allowable stress is 2000 kPa. Two pulleys rotate in opposite directions and the centre distance of the shaft is 750 mm. The co-efficient of friction is 0.3 for both the pulleys. Determine the width of the belt. 10

[Turn over

5. At a point in a strained material, the normal tensile stresses are  $60 \text{ N/mm}^2$  and  $30 \text{ N/mm}^2$ . Determine by Mohr's circle, the resultant intensity of stress on a plane inclined at  $40^\circ$  to the axis of the minor stress. Also check the answer analytically. 10
6. Explain RMS value method and Rz value method to measure the roughness. 10
7. With the help of a block diagram, explain the working of an electrical comparator. 10
8. Discuss Sampling plan versus Control charts to control the quality of work in process, either installing the control charts at the machine or inspection of the product by means of a sampling plan. 10
9. How is machinability connected to tool life ? 10
10. An automotive single-plate clutch consists of a pair of contacting surfaces. The inner and outer radii of friction plate are 120 mm and 250 mm respectively. The co-efficient of friction is 0.25 and the total axial force is 15 kN. Calculate the power transmitting capacity of the clutch plate at 500 r.p.m., using 10
  - (i) Uniform wear theory and
  - (ii) Uniform pressure theory
11. Explain the terms Spin and Precession as related to Gyroscope. How do they differ from each other ? 10

**PART C**

6×15=90

Answer all the following questions. Each question carries 15 marks.  
Answers for theory questions are not to exceed about 150 words each.

12. Fit a second order polynomial to the data given in the Table shown below. Also show the error analysis. 15

$x_i$	$y_i$
0	2.1
1	7.7
2	13.6
3	27.2
4	40.9
5	61.1

Also find the standard error and correlation co-efficient. Comment on the result.

13. It is required to drill a hole of 1.69 mm diameter to a depth of 7.32 mm in steel sheet using R - C circuit by electro-discharge machining method using a brass electrode. The surface finish required is to be 20 micron. Determine the source voltage to be set up for a condenser and resistance setting of 120 micro-farads and 100 ohms respectively. Also find out the time required for drilling. Assume sparking period = 100  $\mu$ -sec. 15

Given that

- (i) Surface roughness =  $K_1(1/2 CU^2)^{K_2} t_p^{K_3}$  microns where  $K_1$ ,  $K_2$  and  $K_3$  are constants and their values for brass electrode and steel work piece are 13, 0.45, and 0.22 respectively.

C = capacitance of the condenser in farads

U = voltage across the capacitor

$t_p$  = pulse duration in  $\mu$ -sec.

- (ii) Metal removal rate =  $1.42 t_c U^2$  mm<sup>3</sup>/sec ( $t_c$  = charging time).

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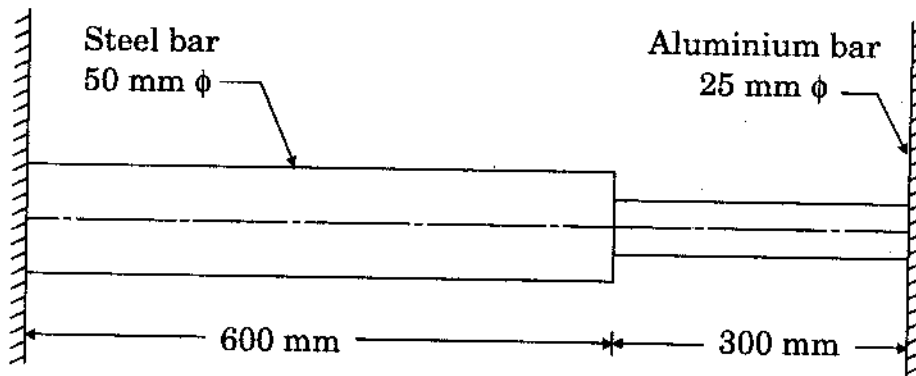
14. With the help of a neat sketch explain the stress and strain curve of a ductile material. 15
15. Explain what is Jig and Fixture. Enumerate the operational factors that must be considered to achieve the most efficient clamping for holding jig or fixture. 15
16. Define the term "Whirling speed of a shaft". Prove that the whirling speed of a shaft in r.p.s. (revolutions per second) is given by the relation,  
$$N_C = \frac{0.4985}{\sqrt{\delta}}$$
 15
17. Explain with the help of sketch how the energy distribution takes place in explosive forming process to various components. 15

## PART D

3×30=90

Answer any **three** of the following questions. Each question carries 30 marks. Answers for theory questions are not to exceed 300 words each.

18. What do you mean by 'steering gear' ? Derive an expression for the fundamental equation of correct gear. 30
19. With the help of a neat sketch explain the working of Electrochemical Machining. What are its advantages and limitations ? Discuss about Electrochemical Machining suitability and applications. 30
20. A composite bar made up of aluminium and steel, is held between two supports as shown in the figure.



The bars are stress free at a temperature of 38°C. What will be the stresses in the two bars, when the temperature is 21°C, if 30

- (a) The supports are unyielding and
- (b) The supports come nearer to each other by 0.1 mm. It can be assumed that the change of temperature is uniform all along the length of the bar.

Take  $E$  for steel as  $210 \text{ kN/mm}^2$ ,  $E$  for aluminium as  $74 \text{ kN/mm}^2$  and co-efficient of expansion for steel as  $11.7 \times 10^{-6}$  per °C, co-efficient of expansion as  $23.4 \times 10^{-6}$  per °C.

[Turn over

21. (a) A number of masses (say four masses) are attached to a shaft which is rotating at an angular speed of  $\omega$  rad/s. If all the masses are in the same plane, then describe the analytical and graphical method of balancing these four masses by a single mass only. 15
- (b) Derive an expression for the height of Watt governor and prove that the height of the governor is inversely proportional to the square of the speed of the Governor. 15
22. (a) Outline the necessary steps in connection with using the control charts for  $\bar{X}$  and R for any quality characteristic of manufactured product. 10
- (b) What factors should be taken into consideration by a firm when determining. 20
- (i) The sample size
  - (ii) The manner in which items should be selected for inclusion in the sample
  - (iii) The frequency of sampling
  - (iv) The operations to be controlled by control charts for variables

**SEAL**



**2010**  
**MECHANICAL ENGINEERING**

**Paper 2**

*Time : 3 Hours ]*

*[ Maximum Marks : 300*

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**INSTRUCTIONS**

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However, they have to choose only **three** questions in Part D.*

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| <b>C</b> | 90 marks  |
| <b>D</b> | 90 marks  |

*Marks allotted to each question are indicated in each part.*

[Turn over

**SEAL**

**PART A**

4×5=20

*Answer all the following questions in about 50 words. Each question carries 5 marks.*

1. (a) Enumerate the factors which contribute to internal load gain as concerned with summer comfort air conditioning. 5
- (b) Define the following non-dimensional numbers : 5
  - (i) Grashof Number
  - (ii) Raleigh Number
- (c) Explain what is meant by transient heat conduction. 5
- (d) Explain what is meant by carburetion. 5

**PART B**

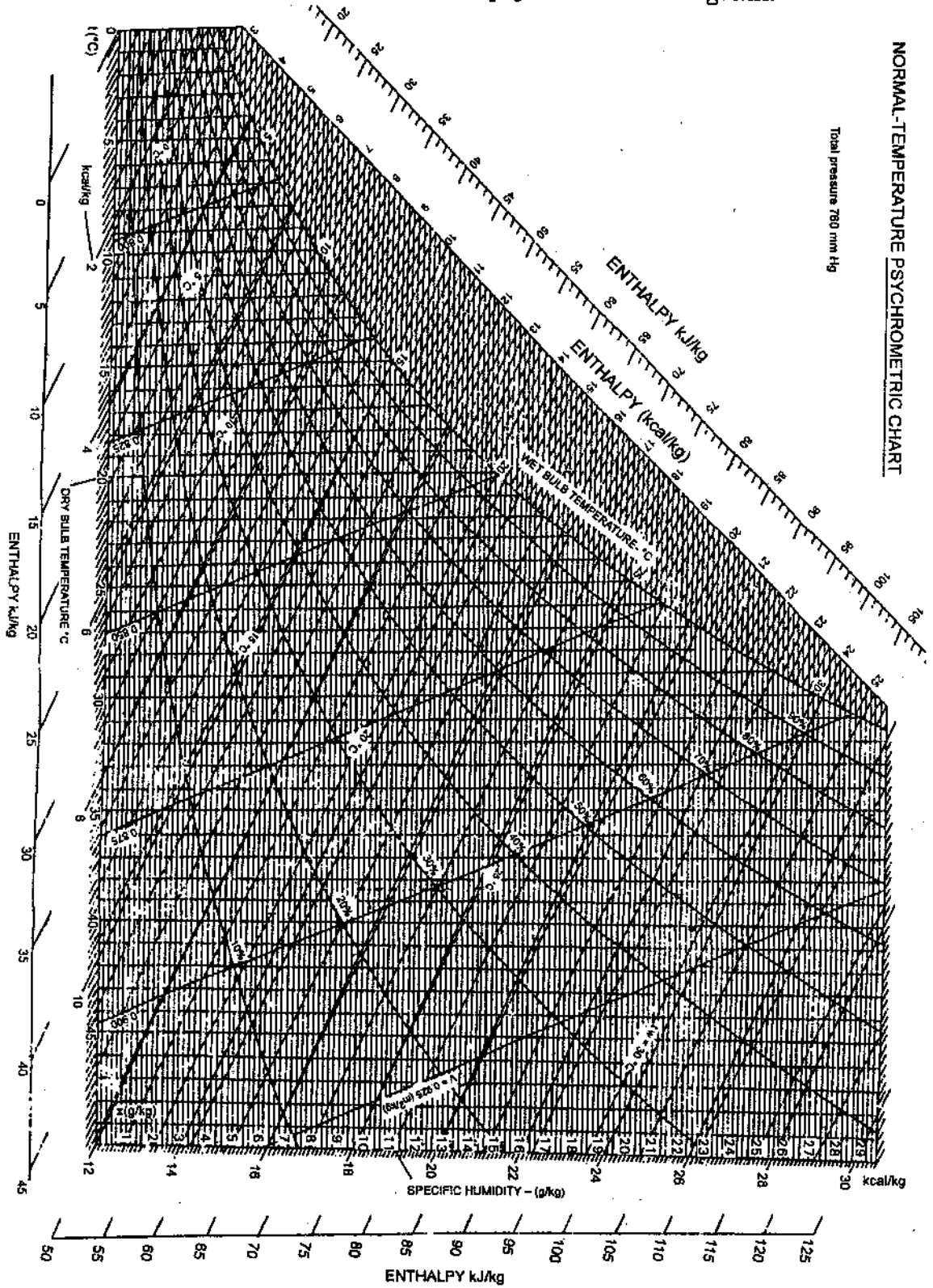
10×10=100

Answer all the following questions. Each question carries 10 marks.  
Answers for theory questions are not to exceed about 100 words each.

2. With the help of a diagram explain the terms transmissivity, absorptivity, reflectivity. When are the surfaces said to be perfect transparent, perfect reflector, perfect absorber ? 10
3. Consider hypothetical heat engines, A, B and C, each operating between 1000 K and 300 K. When each engine involves itself with a heat interaction of 1000 kJ with the high temperature reservoir, it is claimed that while A develops a work of 600 kJ, B and C develop 700 and 800 kJ. Use the Carnot statement and mention whether engines A, B and C are reversible, irreversible or impossible. 10
4. A closed adiabatic wall chamber of height 3 m contains 9 kg of dust uniformly distributed. The kinetic energy of the dust is 100 J as the dust is moving about the chamber. Determine the changes in energy as the dust settles to the bottom. 10
5. Explain the working of the Carnot cycle with the help of T-s diagram. 10
6. Explain the terms (i) After burning, (ii) Preignition as concerned with SI engine. 10
7. Classify the turbines on the basis of, 10
  - (a) Head and quantity of water available.
  - (b) Hydraulic action of water.
  - (c) Direction of flow of water with respect to runner.
  - (d) Specific speed of turbines.
8. Define the critical thickness of insulation. Derive an expression for thickness of insulation for a cylindrical object. 10
9. (a) Establish the following expression for air water vapour mixture, specific humidity is given by  $\omega = 0.662 \frac{p_v}{p_b - p_v}$  where  $p_v$  is partial pressure of water vapour and  $p_b$  is barometric pressure. 5

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- (b) For a sample of air having 22°C DBT, relative humidity 30 per cent at barometric pressure of 760 mm of Hg, calculate (i) Humidity ratio, (ii) Vapour density and (iii) Enthalpy using the psychrometric chart. Show the markings on a skeletal psychrometric diagram.



10. Draw a neat sketch of the pool boiling curve and mark all the regimes. 10
11. With the help of a neat sketch, explain the development of a boundary layer when a fluid is flowing with a velocity on a flat plate. 10

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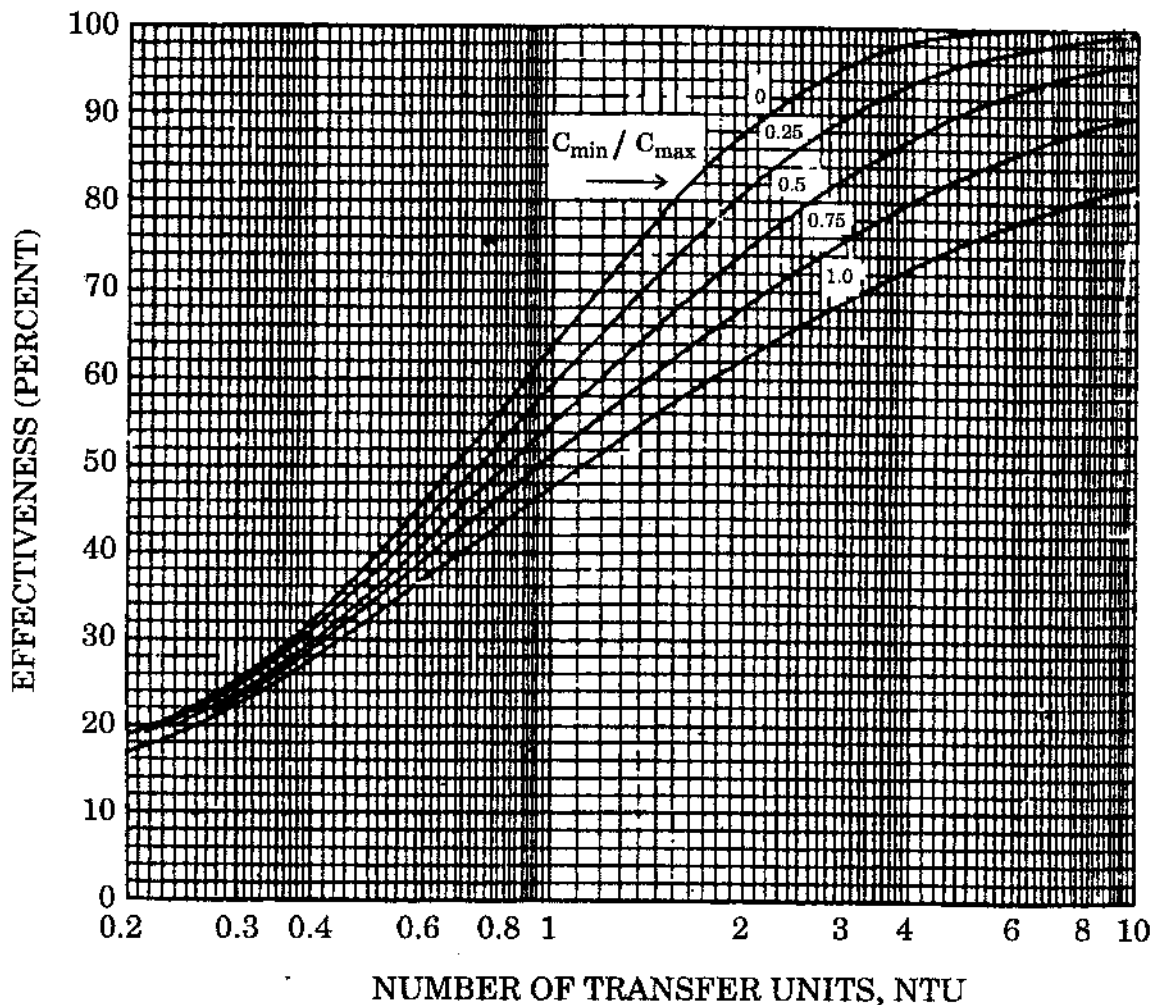
## PART C

6×15=90

Answer all the following questions. Each question carries 15 marks. Answers to theory questions are not to exceed about 150 words each.

12. Air at a rate of 8.5 kg/s and having inlet temperature 135°C is to be cooled in a cross flow heat exchanger (Single pass). Water is used for cooling operation at a rate of 0.6 kg/s and is available at 20°C. Both fluids can be treated as unmixed. The overall heat transfer coefficient for the system is 210 W/m<sup>2</sup> K. The surface area of the exchanger is 200 m<sup>2</sup>. Calculate (i) the outlet temperature of air, (ii) total heat transfer rate. Take specific heat of water 4180 J/kg K, specific heat of air 1005 J/kg K. 15

EFFECTIVENESS – CROSS FLOW,  
BOTH FLUIDS UNMIXED



13. One end of a long rod is inserted into a furnace while the other projects into ambient air. Under steady state the temperature of the end of the rod is measured at two points 75 mm apart and found to be  $125^{\circ}\text{C}$  and  $88.5^{\circ}\text{C}$ , respectively, while the ambient temperature is  $20^{\circ}\text{C}$ . If the rod is 25 mm in diameter and convective heat transfer coefficient is  $23.36 \text{ W/m}^2 \text{ K}$ , find the thermal conductivity of the rod material. 15
14. The resisting force  $F$  of a supersonic plane during the flight can be considered as dependent on the length of aircraft  $L$ , velocity  $V$ , air viscosity  $\mu$ , air density  $\rho$  and bulk modulus of air  $K$ . Express the functional relationship between these variables and the resisting force. 15
15. Draw a neat sketch of a Nuclear Reactor and explain the function of each component. 15
16. Explain the working of Benson Boiler with the help of a sketch. 15
17. With the help of a neat sketch explain the working of a solar still. 15

[Turn over

**PART D**

3×30=90

Answer any **three** of the following questions. Each question carries 30 marks. Answers to theory questions are not to exceed about 300 words each.

18. In an engine working on dual cycle the temperature and pressure at the beginning are 27°C and 1 bar respectively. The compression ratio is 12. The maximum pressure is limited to 70 bar and the total heat supplied is 1500 kJ/kg. Find the following : 30
- Pressure and temperature at all salient points.
  - Air standard efficiency.
  - Mean effective pressure.
19. With the help of neat sketches explain the pressure field due to a source of disturbance when 30
- Source Mach number is less than 1.
  - Source Mach number is equal to 1.
  - Source Mach number is greater than 1.
  - Source is stationary.
20. A single stage air compressor delivers air at 6 bar. The pressure and temperature at the end of suction are 1 bar and 27°C. It delivers 1.5 m<sup>3</sup> of free air per minute when the compressor is running at 350 rpm. The clearance volume is 5% of the stroke volume. The free air condition are 1.013 bar and 15°C. The index of compression and expansion = 1.3. Find 30
- the volumetric efficiency.
  - the bore and stroke of the cylinder if both are equal.
  - the power required if the mechanical efficiency is 80%.
21. With the help of a neat sketch explain the working of an Ejector refrigeration system. Show the states on the T-s diagram. 30
22. Discuss the effect of the following on the performance of a vapour compression system : 30
- Effect of suction pressure
  - Effect of delivery pressure
  - Effect of superheating
  - Effect of subcooling of liquid

**SEAL**