

GUJARAT TECHNOLOGICAL UNIVERSITY
M. E. - SEMESTER – I • EXAMINATION – WINTER • 2013

Subject code: 711002N**Date: 26-12-2013****Subject Name: Vacuum Engineering****Time: 10.30 am – 01.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Explain various regions of gas flow in pipe work with relevant theoretical equations. **07**
- (b) (i) Determine the root mean square speed of hydrogen molecules at 200 K. **07**
(ii) Calculate the volume occupied by air by air molecules colliding with a 2 m^2 area of the confining wall per second at 293 K.
- Q.2** (a) (i) Define different ranges of degree of vacuum. **07**
(ii) A gas filled incandescent lamp when cold at 300 K contains a gas under pressure of 80 kPa. What pressure will there be in the lamp, if the filament has raised the filling gas to a mean temperature of 450 K?
- (b) Determine throughput and mass flow rate through a vacuum system consisting of a 500 mm long section of 50 mm ID tube connected in series to a 375 mm long section of a 25 mm ID tube. The 50 mm tube is connected at a large vessel in which the pressure is 100 mPa, and the pressure at the exit of the 25 mm tube is 5 mPa. The temperature of the air flowing through the system is 300 K. Take the viscosity of air as $18.47 \mu\text{Pa}\cdot\text{s}$. **07**
- OR**
- (b) A vacuum system having a volume of 1.250 m^3 and a surface area of 6.23 m^2 is initially at 1.50 Pa. The specific outgassing rate is $2.50 \times 10^{-6} \text{ Pa}\cdot\text{m}^3/\text{s}$ at 1 hour. The ultimate pressure for system is 0.015 mPa. If the outgassing constant is of 4 hours, determine the system pumping speed required to attain a pressure of 0.150 mPa in 3 hours. **07**
- Q.3** (a) Describe construction and working of Cryosorption Pump with neat figure. Also give its limitations. **07**
- (b) A parallel plate cryopump has the warm surface at 300 K and the cryopanel is maintained at 20 K. The gas within the vacuum space is nitrogen, which has a vapour pressure of 6.0 nPa at 20 K. The sticking coefficient is 0.95 and the operating pressure of the system is 80 nPa. A pumping speed of $25 \text{ m}^3/\text{s}$ is required. Determine the required cryopanel surface area. **07**
- OR**
- Q.3** (a) Describe construction and characteristics of Hot Cathode Getter-Ion Pump with neat figure. Also draw and explain its speed curve with and without backed by diffusion pump. **07**
- (b) Explain square scale method of measurement of pressure by the McLeod gauge. Also calculate the change of height (h) of mercury in the capillary by increasing its diameter from 1 mm to 3 mm during measurement of 10^{-3} Pa pressure. The **07**

volume of measuring capillary and bulb is 0.7 liter.

- Q.4** (a) Describe the trouble shooting sequence for the oil sealed Rotary Vanes vacuum pump. Also justify the need of Gas-ballast device for this vacuum pump. **07**
- (b) Describe the role of Trap used in vacuum pump. Also explain working of the Electrical (Ion) Trap with necessary figure showing its components. **07**

OR

- Q.4** (a) Describe working of Cold-Cathode Sputter-Ion gauge with figure. Also give its equation for electrical discharge current (I_d) in terms of relational parameters. **07**
- (b) Explain the laboratory procedure for measurement of the pump speed (S_p) for mechanical vacuum pump with necessary figure. **07**

- Q.5** (a) Describe with figure about the Mass Spectrometric Leak Detector. Also write its limitations. **07**
- (b) Classify the motion seals according to the design. Draw the at least one sketch of the each design of the motion seals. **07**

OR

- Q.5** (a) Describe the most basic requirements of Vacuum Valves used for the typical vacuum system. **07**
- (b) Write about significance of various non-metallic materials used for vacuum applications. **07**
