1. (a) Define pH of a solution. Write the expression of net potential across the electrodes of a pH probe. Draw a neat sketch of a combined probe where both the reference and measuring electrodes are housed?

   (b) Discuss the reason behind the high source impedance of a pH probe. What are the desirable characteristics of a pH amplifier? Draw the circuit diagram of such an amplifier.

   (c) Explain the working principle of the rotating concentric cylinder apparatus for measurement of viscosity of a solution.

2. (a) Draw a schematic of pneumatic flapper nozzle system. Derive the expression for P_0/P_s of a flapper nozzle system, where P_0 is the output or pilot pressure and P_s is the supply air pressure.

   (b) Draw the characteristic curve (approximate) of normalized output pressure vs. normalized displacement of the flapper. What is the slope of the linear range?

   (c) With sketch explain the working principle of the flapper nozzle based reverse acting pneumatic relay.

3. (a) Draw the equivalent circuit of a piezoelectric crystal connected to an amplifier. Derive its input output relationship.

   (b) Draw a charge amplifier circuit. How does the use of charge amplifier facilitate the measurement?

   (c) A cylindrical shape piezo electric transducer having diameter of 8 mm, thickness of 4 mm, charge sensitivity of 2×10^{-12} C/N, dielectric constant 4×10^{-11} F/m and modulus of elasticity of 8.6 N/m^2 is used for measurement of small displacement. For input displacement of 10^{-9} m, determine (i) the force to which it is subjected, (ii) the capacitance of the transducer, (ii) the charge generated and (iv) the voltage developed

4. (a) What are the three handshaking signals in IEEE-488 bus system? With the help of timing diagram explain how these signals are used for smooth DATA transfer from instrument to instrument?

   (b) Explain all universal commands.

   (c) Explain the serial and parallel polling in detail.

(Prof. A. Barua)