

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B. Sc. Engineering 1<sup>st</sup> Year 1<sup>st</sup> Term Examination, 2023

Ch 1131  
(Chemistry)

Time: 3 Hours

Total Marks: 210

**N.B.:** i) Answer any THREE questions from each section in separate scripts.

ii) Figures in the right margin indicate full marks.

iii) Assume reasonable data if any missing.

**SECTION-A**

- 1(a) " $H_2$  is formed but  $He_2$  doesn't" – explain. 08
- 1(b) " $N_2$  molecule is diamagnetic in nature" – explain. 11
- 1(c) " $H_2O$  is liquid but  $H_2S$  is gas at room temperature" – explain with the help of H-bonding. 09
- 1(d) Explain the bond order of  $N_2$  molecule. 07
- 2(a) " $OCl_6$  doesn't exist but  $SiCl_6$  exist" – explain. 08
- 2(b) What is silicate. Draw the two-dimensional structure of cyclic silicate and sheet silicate. 14
- 2(c) Explain about p-type and n-type semiconductor of Silicon. 09
- 2(d) What are colligative properties. 04
- 3(a) Define Raoult's law. How is the lowering in vapor pressure related to a rise in the boiling point of a solution? 11
- 3(b) Write down the laws of depression of freezing point of solution. Derive a relationship between depression of freezing point and molecular weight of the solute. 12
- 3(c) What is osmosis? 05
- 3(d) The boiling point of an aqueous solution containing 3.5g urea in 50g water is  $101.5^\circ C$ . Calculate the ebullioscopy constant of water. 07
- 4(a) Explain the terms: i) phase, ii) component, and iii) degree of freedom. 12
- 4(b) Derive Gibb's phase rule. 08
- 4(c) Discuss the phase diagram of water as one component system. 10
- 4(d) What is condensed phase rule? 05

**SECTION-B**

- 5(a) What is meant by the rate law of reaction? Derive an expression for the rate constant of a reactant  $A$  at  $t = 0$  to that at  $t = t$  for a first-order reaction. 10
- 5(b) Sketch a potential-energy versus reaction progress plot for the following reactions: 10
- i)  $S(s) + O_2(g) \rightarrow SO_2(g) \quad \Delta H^0 = -296.06 \text{ Kj/mol}$
- ii)  $Cl_2(g) \rightarrow Cl(g) + Cl(g) \quad \Delta H^0 = 242.7 \text{ Kj/mol}$



- 5(c) The reaction  $2A \rightarrow B$  is a first-order in  $A$  with a rate constant of  $2.8 \times 10^{-2} \text{ s}^{-1}$  at  $80^\circ\text{C}$ . How long (in second) will it take for  $A$  to decrease from  $0.88\text{M}$  to  $0.14\text{M}$ ? 08
- 5(d) Write down the difference between order and molecularity. 07
- 6(a) State and explain the law of mass action. 08
- 6(b) Define reaction quotient. How does it differ from equilibrium constant? 09
- 6(c) For which of the following reactions is  $K_c$  equal to  $K_p$ ? 09
- $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$
  - $2\text{H}_2\text{O}(\text{aq}) \rightleftharpoons \text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$
  - $\text{PCl}_3(\text{g}) + 3\text{NH}_3(\text{g}) \rightleftharpoons 3\text{HCl}(\text{g}) + \text{P}(\text{NH}_2)_3(\text{g})$
- 6(d) For the reaction 09
- $$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$$
- $K_p$  is  $4.3 \times 10^{-4}$  at  $375^\circ\text{C}$ . Calculate  $K_c$  for the reaction.
- 7(a) Write down the differences between chemical corrosion and electrochemical corrosion. 11
- 7(b) Discuss the various factors that affect corrosion. 10
- 7(c) Write notes on Corrosion control by proper design 06
- 7(d) Explain the anodic protection of corrosion of metal. 08
- 8(a) What is meant by the position of an equilibrium? Does the addition of a catalyst have any effects on the position at an equilibrium? 10
- 8(b) Explain about pitting corrosion and crevice corrosion. 09
- 8(c) Consider the following reacting system: 08
- $$2\text{NO}(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{NOCl}(\text{g}), \quad \Delta H_f^\circ = 51.7 \text{ KJ/mol}$$
- What combination of temperature and pressure (High/Low) would minimize the yield of  $\text{NOCl}$ ?
- 8(d) Explain the Faraday's laws of electrolysis. 08



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B. Sc. Engineering 1<sup>st</sup> Year 1<sup>st</sup> Term Examination, 2023

EEE 1131

(Electrical Circuits)

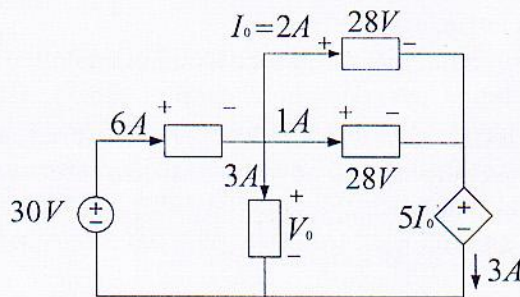
Time: 3 Hours

Total Marks: 210

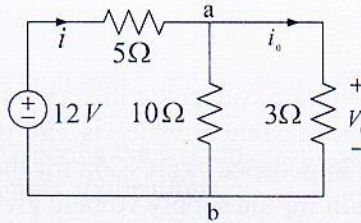
- N.B.:** i) Answer any THREE questions from each section in separate scripts.  
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**SECTION-A**

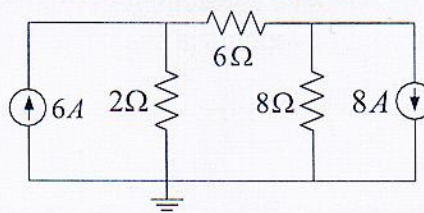
- 1(a) Define resistivity of conductor. Describe the factors determining resistivity of a cylindrical conductor. 10
- 1(b) Define ac current and dc current. Briefly describe passive sign convention with appropriate diagram. Find  $V_0$  and the power absorbed by each element in the following circuit. 15



- 1(c) What is meant by short circuit and open circuit? Find  $i_0$  and  $V_0$  in the following circuit. Also calculate the power dissipated in the  $3\Omega$  resistor. 10

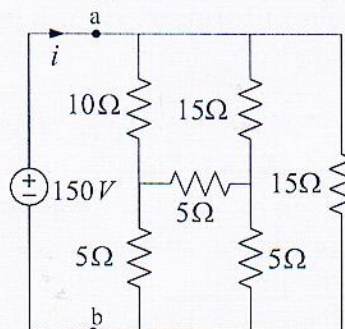


- 2(a) Define (i) node, (ii) mesh, and (iii) linear circuit. 06
- 2(b) Using mesh analysis, determine the current for the network in the following circuit. 12



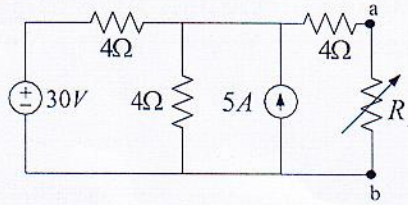
- 2(c) Deduce the condition for maximum power transfer. Under maximum power transfer condition, show that efficiency is 50%. 10
- 2(d) What is electrical source? Classify electrical sources. Define independent and dependent sources. 07

- 3(a) Define potential difference, current, and power. 09
- 3(b) Obtain the equivalent resistance  $R_{ab}$  for the following circuit and find the current  $i$ . 13





3(c) Find the current through  $R_L$  when the value of  $R_L = 616\Omega$  and  $36\Omega$ . 13



4(a) What are the differences between electrical circuit and magnetic circuit? 13

Define: (i) magnetic flux density, (ii) magnetic field density, and (iii) reluctance.

4(b) What is Ampere's circuital law? Explain the hysteresis loop of ferromagnetic material. 10  
Show residual flux and coercive force in the hysteresis loop.

4(c) Classify the losses in the magnetic circuit and explain them. Mention the process for loss reduction in magnetic circuit. 12

### SECTION-B

5(a) Explain the terms with necessary illustration 10

(i) Oscillating current, (ii) Period current, (iii) Alternative current, (iv) Period, and (v) Cycle

5(b) Define impedance. Define the equation of an 'L' branch. Show the graphical representation of voltage, current, and power variation in that branch. 12

5(c) What is phasor? Write the magnificence of operator  $j$ . Express the expression  $\sqrt{4.5 - j7.79} + \log_e 10 \angle 172^\circ$  as a signal number. 08

5(d) Draw vector diagram of  $R, L, C, R - L$ , and  $R - L - C$  branches. 05

6(a) Deduce the values of crest factor and form factor of a pure sine wave. 10

6(b) Find the expressions for the energy stored during a quarter cycle of an inductor and capacitor. 13

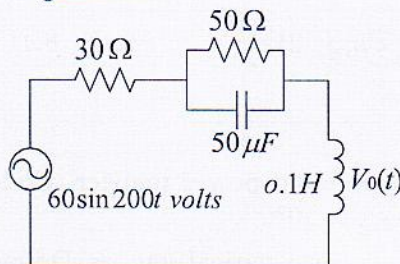
6(c)  $R = 10\Omega$ , and  $L = 0.05$  henry are connected in series and energized by a 25 - cycle sinusoidal voltage. The maximum value of which is 150 volts. 12

(i) Find the complete impedance expression for the  $RL$  branch.  
(ii) Write the expression for the supply voltage given  $v = 75$  at  $t = 0$   
(iii) Write the expression for current as a function of time.

7(a) Briefly explain the characteristics of series and parallel resonances. 06

7(b) Define real power, reactive power, and apparent power of an ac circuit. 09

7(c) Calculate  $V_0(t)$  in the following circuit. 10



7(d) Explain the two-wattmeter method of power measurement of balanced 3 -  $\phi$  load with proper vector diagram. 10

8(a) Determine the relations among voltages and currents of n-phase star and mesh systems. 10

8(b) The line voltages  $V_L = 220$  volts of balanced wye and delta systems, find line current, phase current, phase power, and total power. Given  $R = 6\Omega$  and  $X = 8\Omega$  in each branch. 12

8(c) A 5hp motor with a 0.6 lagging power factor and an efficiency of 92% is connected to a 208 V, 60Hz supply. (i) Establish the p.f. triangle for the load, (ii) Determine the P.f. capacitor that must be placed in parallel with the load to raise the P.f. to unity. (iii) Determine the percentage change in supply current from uncompensated to compensated system. 13



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HUM 1131

(Sociology and Engineering Ethics)

Time: 3 Hours

Total Marks: 210

**N.B.:** i) Answer any THREE questions from each section in separate scripts.

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**SECTION-A**

- |  |    |
|--|----|
| 1(a) What is sociology?  | 05 |
| 1(b) Critically discuss scope of sociology in the context of Bangladesh.                                 | 15 |
| 1(c) Describe the importance of studying sociology for the students of mechatronics engineering.         | 15 |
| 2(a) What do you mean by society? Discuss briefly the characteristics of society.                        | 15 |
| 2(b) What is the difference between institution and association?   | 10 |
| 2(c) Define social stratification. Explain social stratification on the basis of Marx's view.            | 10 |
| 3(a) Define culture. Describe briefly the element of culture.  | 15 |
| 3(b) What is social research? Explain the methods of research in sociology.                              | 15 |
| 3(c) What is cultural hybridization? Explain with example.   | 05 |
| 4(a) What do you mean by social structure? Narrate the bases of social structure according to Karl Marx. | 15 |
| 4(b) Define Kinship. Explain the types of Kinship with example.  | 15 |
| 4(c) What are the steps of scientific research.  | 05 |

**SECTION-B**

- |  |    |
|--|----|
| 5(a) What is engineering ethics?   | 10 |
| 5(b) What are the traits of a professional engineer?   | 10 |
| 5(c) How does ethics influence engineering profession?   | 15 |
| 6(a) Define utilitarianism.  | 10 |
| 6(b) Why Bentham's utilitarianism criticized for being an ethics "worthy of only swine"?                               | 10 |
| 6(c) Critically examine the moral idea of the "Greatest happiness of the greatest number".                             | 15 |
| 7(a) What is the fundamental moral concept in ethics?  | 10 |
| 7(b) What is the difference between duty and responsibility?   | 10 |
| 7(c) Write down the EEE fundamental code of ethics and code of conduct with brief explanation.                         | 15 |
| 8(a) How does globalization influence engineering ethics?  | 10 |
| 8(b) Explain about three approaches of respect for persons honesty.  | 10 |
| 8(c) Briefly discuss the professional obligations and fundamental rules of NSPE. What is the aim and objective of IEB? | 15 |



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Math 1131

(Calculus and Geometry)

Time: 3 Hours

Total Marks: 210

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**SECTION-A**

- 1(a) Reduce the equation  $x^2 + 2xy + y^2 - 6x - 2y + 4 = 0$  to standard form and identify the conic. Also find its focus. 20
- 1(b) If possible, find the vertex of the conic  $x^2 + 4xy + y^2 - 2x + 2y - 6 = 0$ . Also, remove the product term ( $xy$ ) from the above equation by using appropriate transformation. 15
- 2(a) Find the cartesian and spherical polar co-ordinates of the point  $(4, \frac{5\pi}{3}, -2)$ . 10
- 2(b) A line makes angles  $\alpha, \beta, \gamma, \delta$  with the four diagonals of a cube. Find the value of  $\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma + \cos^2 \delta$ . 13
- 2(c) Find the equation of the plane through  $(2, 3, -4)$  and  $(1, -1, 3)$  and parallel to the  $x$  axis. 12
- 3(a) Find the equation of the plane passing through the lines of intersection of the planes  $2x - y = 0$  and  $3z - y = 0$  and perpendicular to the plane  $4x + 5y - 3z + 1 = 0$ . 12
- 3(b) Find the length of the shortest distance between the lines  $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$  and  $\frac{x-2}{3} = \frac{y-4}{4} = \frac{z-5}{5}$ . 12
- 3(c) Find the coordinates of the point where the line joining the points  $(2, -3, 1)$  and  $(3, -4, -5)$  cuts the plane  $2x + y + z = 7$ . 11
- 4(a) Evaluate  $\int_0^{\pi/4} \frac{x}{1+\cos 2x+\sin 2x} dx$ . 12
- 4(b)  $\lim_{n \rightarrow \infty} \left[ \frac{1}{n} + \frac{n^2}{(n+1)^3} + \frac{n^2}{(n+2)^3} + \dots + \frac{1}{8n} \right]$  12
- 4(c) Find the reduction formulae for  $\int \sin^m x \cos^n x dx$ . 11

**SECTION-B**

- 5(a) Define the limit of a function at a point. Discuss the continuity and differentiability of the function  $f(x) = |x| + |x + 2|$  at  $x = -2$ . 13
- 5(b) Find the differential coefficient of  $y$  where  $y = x^{\tan^{-1} x} + (\sin x)^{\ln x}$ . 10
- 5(c) Define point of inflection of a function. If exist, find the point of inflection for the function  $f(x) = 2x^3 - 6x^2 + 12x + 24$ . 12

- 6(a) State Rolle's theorem. Is Rolle's theorem applicable for the function  $f(x) = \frac{2}{2+|x|}$  in any interval containing origin? Justify your answer. 12
- 6(b) State Leibnitz's theorem and use it to find an equation connecting  $y_n, y_{n+1}$  and  $y_{n+2}$  where  $y = (\cos^{-1} x)^2$ . 12
- 6(c) Find the value of  $\sin 38^\circ$  by using Taylor's expansion. 11
- 7(a) Find the extreme values, if exist of  $xy$  subject to the condition  $3x + 4y = 5$ . 11
- 7(b) If  $u = x^n F\left(\frac{y}{x}, \frac{z}{x}\right)$ , then find the value of  $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} + z \frac{\partial u}{\partial z}$ . 12
- 7(c) Write the statement of Euler's theorem as homogeneous function. If  $u = 2\cos^{-1}\left(\frac{x+y}{\sqrt{x+y}}\right)$ , then find the value of  $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y}$ . 12
- 8(a) Find all possible asymptotes for the curve  $(x+2)(y^2+2y+2) - 5x + 2y^2 - 6y + 10 = 0$ . 13
- 8(b) Find the equation of tangent perpendicular to the straight line  $4x - 8y - 3 = 0$  of the parabola  $3x^2 + 6y - 24 = 0$ . 12
- 8(c) Find the radius of curvature of the curve  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$  at the point  $(0, b)$ . 10



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MTE 1101

(Mechatronic Systems)

Time: 3 Hours

Total Marks: 210

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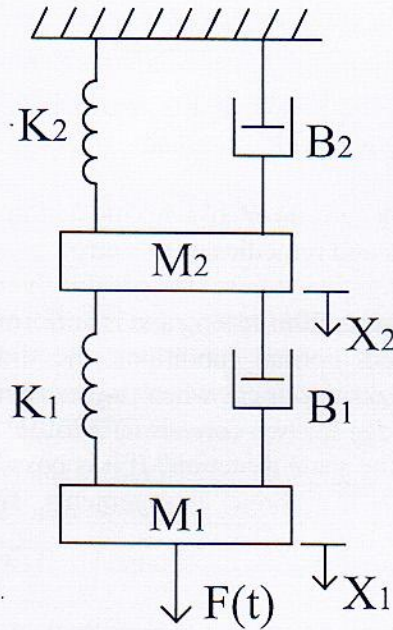
**SECTION-A**

- |      |  |    |
|------|--|----|
| 1(a) | What is mechatronics engineering? How is the fourth industrial revolution related to mechatronics engineering? Explain with examples.  | 13 |
| 1(b) | Suppose your voltmeter shows zero error in instrumentation lab. What type of error is this? Make a list of the sources and remedies of this error.   | 12 |
| 1(c) | A linear resistance potentiometer is 50mm long and is uniformly wound with wire having a resistance of 10,000Ω. Under normal conditions, the slider is at the center of the potentiometer. Find the linear displacement when the resistance of the potentiometer as measured by a Wheatstone bridge for two cores is (i) 3850Ω, and (ii) 7560Ω. Are the two displacements in the same direction? If it is possible to measure a minimum value of 10Ω resistance with the above arrangements, find the resolution of the potentiometer in mm. | 10 |
| 2(a) | Write short note on: (i) Dead time, (ii) Settling time, (iii) Hysteresis error, (iv) Non-linear error, (v) Sensitivity.  | 10 |
| 2(b) | Write down the analogy between human control and computer control.   | 10 |
| 2(c) | What is a Hall effect sensor? Describe the working principle of the Hall effect sensor with necessary figure. Also mention its applications.   | 15 |
| 3(a) | “A metal detector is a proximity sensor”. Justify the statement.   | 08 |
| 3(b) | In a Wheatstone bridge, a strain gauge is used as a Quarter Bridge. Drive the relation between the gauge factor and the change in output voltage when the bridge is unbalanced.  | 10 |
| 3(c) | What is meant by signal conditioning? List the ideal characteristics of an operational amplifier.  | 10 |
| 3(d) | Define filtering in signal conditioning. Distinguish between active filter and passive filter.   | 07 |
| 4(a) | List the components used in analog to digital data conversion. Also describe the conversion process.   | 12 |
| 4(b) | What is multiplexing? Describe the working principle of Cathode Ray Oscilloscope (CRO) with necessary figure.  | 12 |
| 4(c) | Describe the different stages involved in a typical measurement system installation.   | 06 |
| 4(d) | Mention the advantages of LED displays over traditional LCD displays.  | 05 |

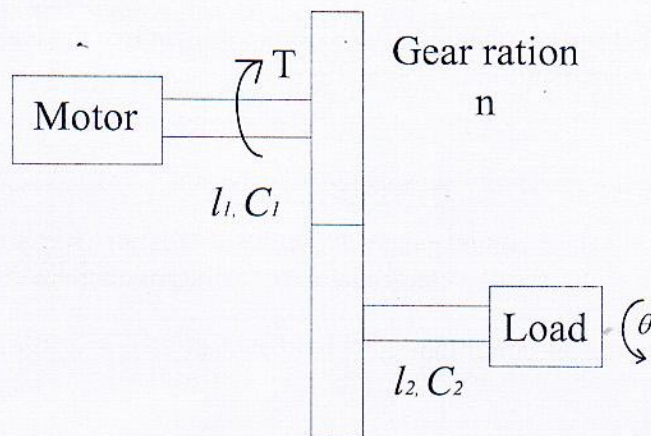


## SECTION-B

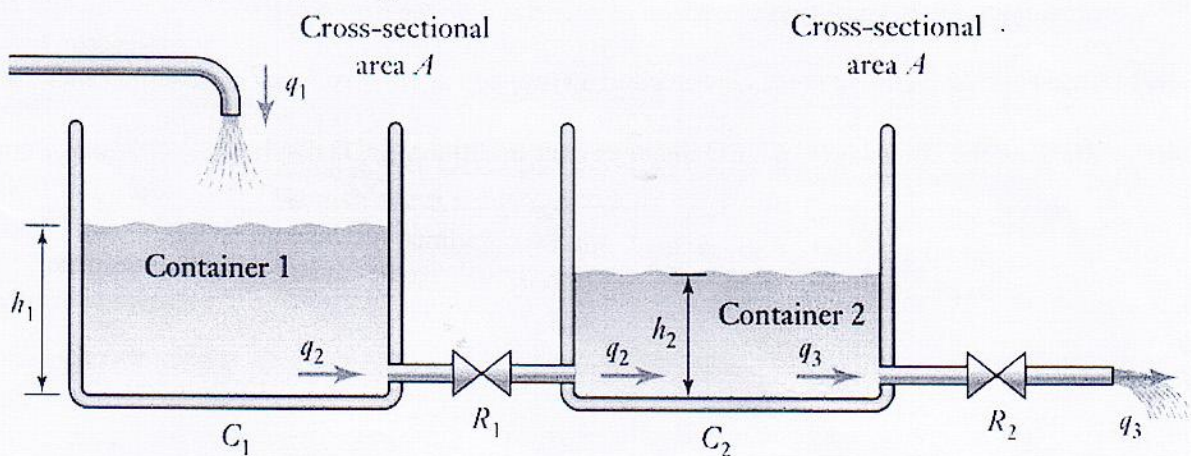
- 5(a) What are the properties that make a system linear? "The relationship between the force  $F$  and the extension  $x$  produced for an ideal spring is linear, being given by  $F = Kx$ ." Justify the statement with proper explanation. 12
- 5(b) Is there any way to linearize a non-linear system? Support your answer with proper explanation. 08
- 5(c) Draw the free body diagram and write the differential equation of the system given below. 15



- 6(a) Drive the differential equation for a motor driving a load through a gear system as given in the following figure, which relates the angular displacement of the load with time. 10

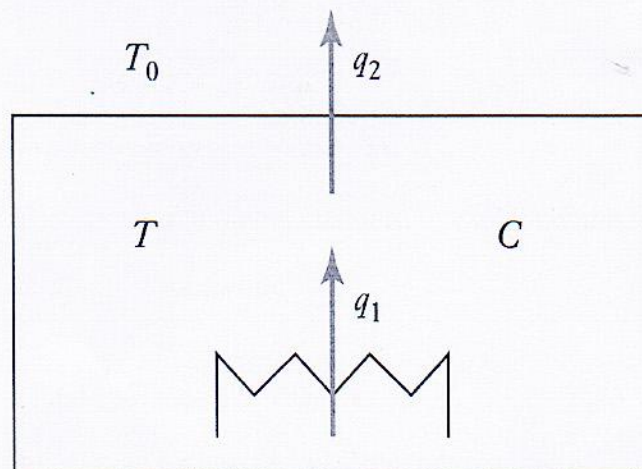


- 6(b) Draw the relationship between volume rate of flow and mass rate of flow. Why is mass rate flow used instead of volume rate flow for the modeling of Pneumatic system? 10
- 6(c) Derive the relationship which describes how the heights of the liquids in the two containers will change with time for the hydraulic system shown in figure where liquid flow rate changes only slowly. 15

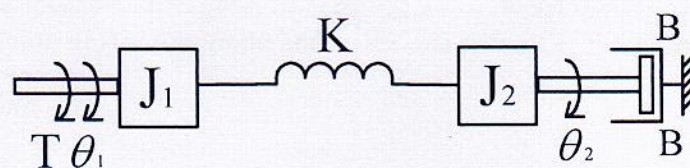




- 7(a) Explain the significance of pulse width modulation (PWM) in controlling servo motors. 06
- 7(b) What is meant by fluid power actuator? What are the challenges associated with the integration of actuators in complex automation systems? 12
- 7(c) Distinguish between transient response and steady state responses. What are the main differences between natural responses and forced responses? 05
- 7(d) Drive an equation describing how the room temperature will change with time for thermal system shown in figure consisting of an electric fire in a room. Assume the fire emits heat at the rate,  $q_1$  and room loses heat at the rate,  $q_2$ . The air in the room is at a uniform temperature,  $T$  and there is no heat storage in the walls of the room. 12



- 8(a) What is solenoid? Discuss the use of a solenoid as an electrical actuation system with an example. 06
- 8(b) Why are stepper motors used in robotic arms instead of conventional d.c. motors? 07
- 8(c) Find the transfer function of the mechanical rotational system shown below. 10



- 8(d) Derive the relationship between the output, the potential difference across the resistor  $R$  of  $V_R$ , and the input  $V$  for the series  $LCR$  circuit shown in below. 12

