

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B. Sc. Engineering 1st Year 1st Term Examination, 2019

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) What type of bonding involves in silicon? Draw the crystal structure of silicon and discuss its technological applications in our daily life. 10
- 1(b) Draw the molecular orbital diagram of O₂ and predict about bond order and magnetic properties. 10
- 1(c) "Metal has high density" – Explain based on its crystal structures. 08
- 1(d) Draw the structure of *d* orbitals and mention its impact on *d-d* splitting. 07
- 2(a) Define corrosion. Write the reaction mechanism of 'Environmental corrosion'. 10
- 2(b) Discuss the effect of humidity and dust particle on the rate of atmospheric corrosion. 08
- 2(c) What is local cell corrosion? Write down the impacts of local cell corrosion in our daily life. 10
- 2(d) Write short note on "Sacrificial Anode". 07
- 3(a) What is mass defect? How it is related to the binding energy and stability of the nucleus, explain with diagram. 10
- 3(b) Draw a thematic diagram of a nuclear power plant and explain how it works. 10
- 3(c) The mass of ¹⁶O is 15.994910 amu. Calculate its binding energy per nucleon. 07
- 3(d) What are the pros and cons of having nuclear power plants in Bangladesh? 08
- 4(a) Explain the terms:
(i) Phase (ii) Component (iii) Degree of freedom and (iv) Triple point. 12
- 4(b) "Water is the best solvent" – Explain based on H-bond concepts. 10
- 4(c) Describe one component system of water with the help of the phase diagram. 13

SECTION-B

- 5(a) Explain the terms lowering of vapour pressure and relative lowering of vapour pressure. What are their units? 10
- 5(b) Derive a relationship between the elevation in boiling point of a solution and the mole fraction of the solute from thermodynamic considerations. 08

- 5(c) State and derive Raoult's law for lowering of vapour pressure. How is this law used for the determination of molecular mass of a non-volatile solute? 09
- 5(d) What is isotonic solution? Calculate the Osmotic pressure of a 5% solution of glucose (mol wt = 180) at 18°C. 08
- 6(a) What is meant by chemical equilibrium constant? Derive the expression for equilibrium constant of the reaction: 10
- $$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g}).$$
- 6(b) Derive the relation between free energy change and equilibrium constant. 08
- 6(c) 13.5 mL of HI is produced by the interaction of 8.1 mL of Hydrogen and 9.3 mL of Iodine vapour at 444°C. Calculate the equilibrium constant at this temperature of the reaction – 07
- $$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g}).$$
- 6(d) What is meant by solvent extraction? Prove that the efficiency of multiple extraction process by same amount of solvent is higher than that of single one. 10
- 7(a) What is meant by the rate of a reaction? How does the rate constant for a reaction vary with the temperature? 12
- 7(b) Differentiate between order and molecularity of a reaction. 08
- 7(c) For a certain first order reaction $t_{1/2}$ is 100 sec. How long will it take for the reaction to be completed 75%? 07
- 7(d) "The reactions of higher order rate" – explain. 08
- 8(a) Why chemical equilibrium is called a dynamic equilibrium? 08
- 8(b) Prove that under specified condition a second order reaction follows the kinetics of a first order reaction. 08
- 8(c) What is steady state approximation? "Steady state approximation reduces the complexity of a reaction" – Explain. 09
- 8(d) Determine the rate of the reaction, $\text{A} + 2\text{B} \rightarrow \text{C}$, from following data: 10

Exp. No.	Initial [A] (in M)	Initial [B] (in M)	Initial rate [C] (in M/S)
1	0.1	0.1	5.5×10^{-6}
2	0.2	0.1	2.2×10^{-5}
3	0.4	0.1	8.8×10^{-5}
4	0.1	0.3	1.65×10^{-5}
5	0.1	0.6	3.3×10^{-5}

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 1st Year 1st Term Examination, 2019

EE 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 Branch and Node. State and explain Kirchoff's voltage and current law. 05
- 1(b) Using voltage divider rule, find the value of unknown resistance shown in Fig. 1(b). 10

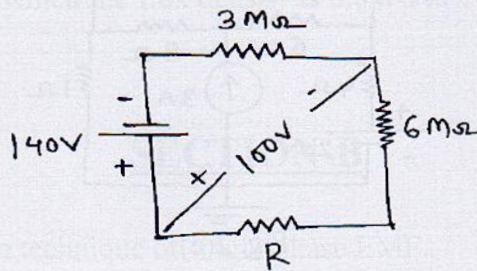


Fig. 1(b)

- 1(c) Determine the values of unknown currents indicated in circuit shown in Fig. 1(c). 10

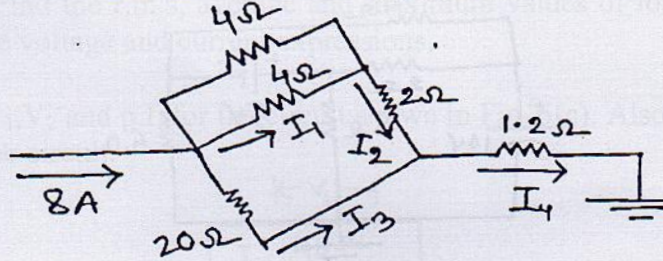


Fig. 1(c)

- 1(d) Determine the value of power delivered to the load $R_L = 6\Omega$ shown in Fig. 1(d). 10

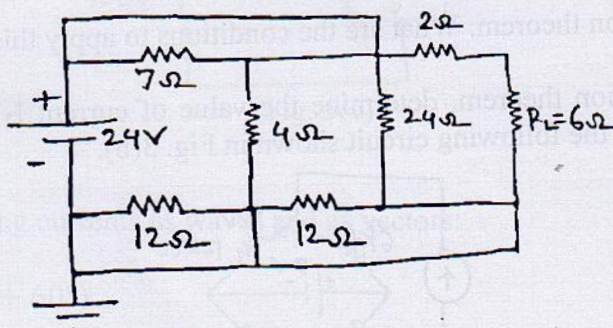


Fig. 1(d)

- 2(a) Deduce the expression of R_1, R_2, R_3 in terms of R_A, R_B, R_C for the following circuit shown in Fig. 2(a). 12

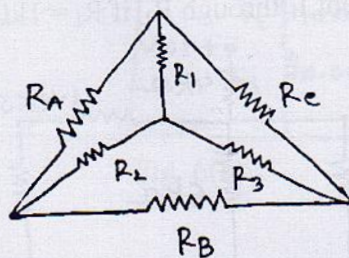


Fig. 2(a)

- 2(b) Find the equivalent resistance R_{ab} between terminal a and b. Also determine the value of I for the following circuit shown in Fig. 2(b). 10

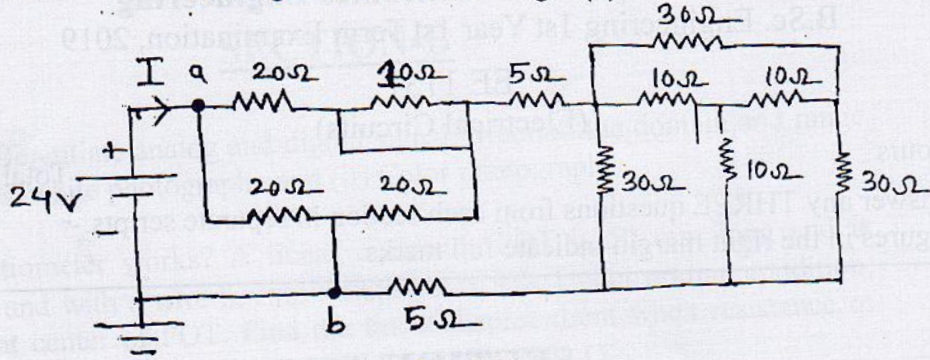


Fig. 2(b)

- 2(c) Define mesh. Find the mesh current of the circuit shown in Fig. 2(c) by using mesh analysis. 07

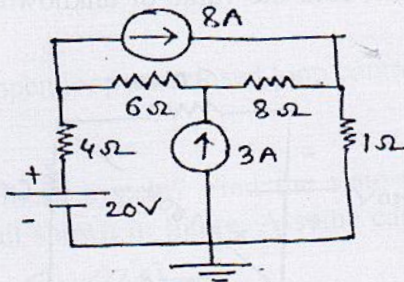


Fig. 2(c)

- 2(d) What is meant by supernode? Determine the node voltages and branch current for the following circuit shown in Fig. 2(d). 06

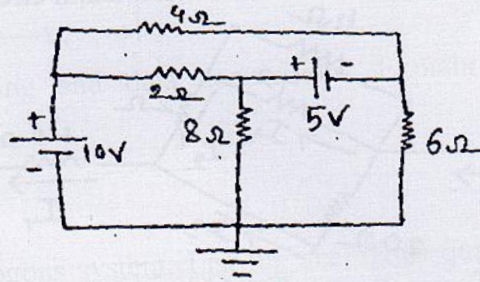


Fig. 2(d)

- 3(a) State superposition theorem. What are the conditions to apply this theorem? 05
- 3(b) Using superposition theorem, determine the value of current I_2 flowing through $12k\Omega$ resistor for the following circuit shown in Fig. 3(b). 15

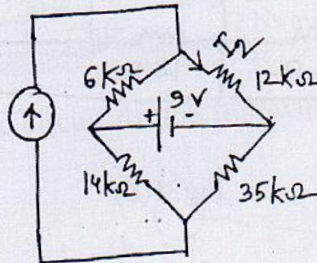


Fig. 3(b)

- 3(c) Determine the Thevenin equivalent circuit for the load R_L as shown in Fig. 3(c), hence find the value of current I_L through R_L if $R_L = 1k\Omega$. 15

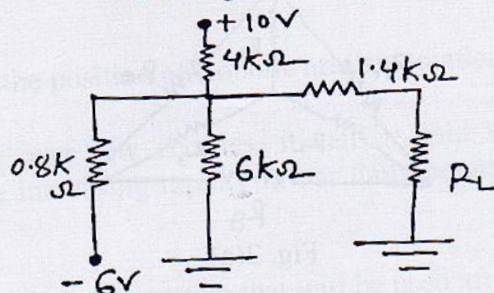


Fig. 3(c)

- 4(a) Where is Ampere's circuital law used? Find the magnetic field intensity at a point 5cm distant from the midpoint of a straight wire 20cm long and carrying a current of 10A. 12
- 4(b) What mmf will be required to establish a flux of 0.005 Wb in the magnetic circuit shown in Fig. 4(b). The material is annealed sheet-steel laminations stacked to obtain the required thickness. 15

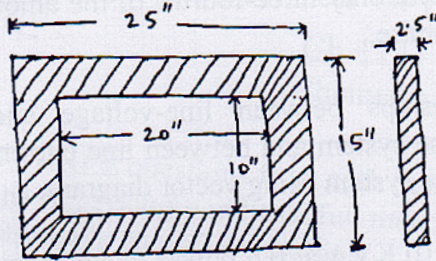


Fig. 4(b)

- 4(c) A straight conductor which carries a current of 50A lies perpendicular to the lines of a magnetic field in which the flux density is 0.8 Wb/m^2 . Calculate the force per meter of conductor. 08

SECTION-B

- 5(a) Explain the generation technique of single-phase EMF. 10
- 5(b) A sinusoidal AC supply of $220 \angle 0^\circ$ is connected to your house for driving an electrical load. The resistance and inductance of the load are 10Ω and 10 mH , respectively. Find the r.m.s, average and maximum values of load current. Also write down the voltage and current expressions. 10
- 5(c) Find I , I_1 , I_2 , V_1 , V_2 and p.f. for the circuit shown in Fig. 5(c). Also draw the vector diagram for the circuit. 15

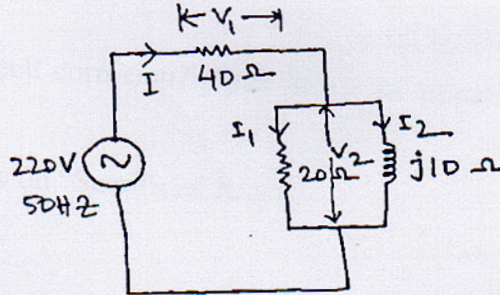


Fig. 5(c)

- 6(a) Add the following currents as waves and as vectors:
 $i_1 = 5 \sin \omega t$
 $i_2 = 10 \sin (\omega t + 60^\circ)$ 10
- 6(b) Find the readings of ammeters I_1 , I_2 , I and of wattmeter W of Fig. 6(b). Compare the readings of W with $I_1^2 R_1$ and $I_2^2 R_2$. 12

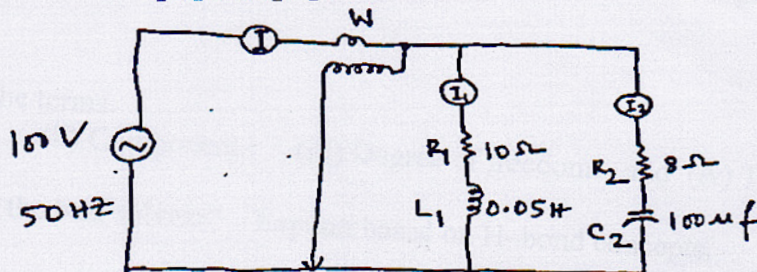


Fig. 6(b)

- 6(c) Express $\log_e \sqrt{\frac{125 \angle -90^\circ}{5 \angle 90^\circ}}$ in rectangular form. 06
- 6(d) Explain the power factor correction technique for an electrical circuit. 07

- 7(a) What are the main differences between single-phase and three-phase EMF generations? 05
- 7(b) Show that the same amount of power may be transmitted over a fixed distance with a fixed line loss with only three-fourths of the amount of copper that would be required for single-phase. 07
- 7(c) Establish the relationships between line-voltage and phase voltage of a Y-connected three-phase system and between line current and phase current of a Δ -connected three-phase system using vector diagram. 08
- 7(d) A 3-phase motor takes 10 KVA at 0.6 power factor lagging from a source of 220 volts. It is in parallel with a balanced delta load having 16Ω resistance and 12Ω capacitive reactance in series in each phase. Find the total volt-amperes, power, line current and power factor of the combination. 15
- 8(a) What are the advantages of neutral wire connection in a 3-phase Y-connected system? 05
- 8(b) Explain two-wattmeter method for measuring three phase power for a balanced Y-connected load with proper diagrams. 15
- 8(c) What is meant by phase sequence? Explain the two-lamp method for the determination of phase sequence of a three phase system with necessary phasor diagram. 15

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B. Sc. Engineering 1st Year 1st Term Examination, 2019

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.

ii) Figures in the right margin indicate full marks.

SECTION-A

- 1(a) "Sociology is the science of social institution" – do you agree this statement? Give reason in favor of your opinion. 10
- 1(b) Explain importance of Sociological knowledge for the students of Mechatronics Engineering department. 10
- 1(c) Explain the role of industrial revolution behind origin and development of Sociology as a distinct discipline. 15
- 2(a) Describe contribution of Auguste Comte behind origin and development of sociology as a science. 10
- 2(b) Explain scope of Sociology with relevant example from our country. 10
- 2(c) What is meant by Society? Explain types of Society with example. 15
- 3(a) What is meant by Institution? Explain functions of Institution with example. 13
- 3(b) What is Community? Distinguish between role of urban and rural communities in Bangladesh. 12
- 3(c) What is Culture? Explain the elements of Culture. 10
- 4(a) Explain key differences among Capitalism, Socialism, and Communism. 10
- 4(b) "Rapid urbanization is blessing for any country" – do you agree with this statement? Give reasons in favor of your opinion. 15
- 4(c) What is Social change? Discuss the impact of globalization on family and marriage. 10

SECTION-B

- 5(a) What is meant by "Ethics" and "Morality"? "Ethics is the science of ultimate good" – Explain. 12
- 5(b) "Morality is indispensable to religion" – Discuss. 08
- 5(c) What is globalization? Do you believe that it's good for us? Give reasons in favor of your opinion. 15

- 6(a) What are the roles of code of Ethics? Discuss the IEEE or NSPE fundamental codes of ethics. 15
- 6(b) Is Engineering a profession?—Justify. Describe the main characteristics of profession. 10
- 6(c) Define Engineering Ethics? What are the factors influence engineering decision? 10
- 7(a) What is meant by Utilitarianism? “Greatest happiness of the greatest number of people” – Explain. 12
- 7(b) What is the difference between duty and responsibility? As an Engineer what is your responsibility? 08
- 7(c) What is Human Right? Describe about the universal declaration of Human Rights – 1948. 15
- 8(a) Explain about three approaches of Respect for Persons Honesty. 10
- 8(b) What is moral judgment? Explain objectives of moral judgment. 15
- 8(c) Discuss some professional characteristics of a good engineer. 10

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B. Sc. Engineering 1st Year 1st Term Examination, 2019

Math 1131

(Calculus and Geometry)

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 limit and continuity of a function. A function $f(x)$ is defined as follows: 15
- $$f(x) = \begin{cases} 1 + \sin x & \text{for } 0 \leq x < \pi/2 \\ 2 + (x - \pi/2)^2 & \text{for } x \geq \pi/2 \end{cases}$$
- Discuss the continuity and differentiability of $f(x)$ at $x = \pi/2$.
- 1(b) State Rolle's theorem. Is the Rolle's theorem applicable to the function 10
- $$f(x) = x^2 + 5x - 6 \text{ in the interval } (-6, 1)?$$
- 1(c) If $f(x) = \left(\frac{a+x}{b+x}\right)^{a+b+2x}$, show that $f'(0) = \left(2 \log \frac{a}{b} + \frac{b^2 - a^2}{ab}\right) \left(\frac{a}{b}\right)^{a+b}$. 10
- 2(a) State Leibnitz theorem. If $\log y = \tan^{-1} x$, show that 12
- $$(1 + x^2)y_{n+2} + (2nx + 2x - 1)y_{n+1} + n(n+1)y_n = 0.$$
- 2(b) State Mean Value theorem. Verify Mean Value theorem for the function 10
- $$f(x) = 2x - x^2 \text{ in the interval } (0, 1).$$
- 2(c) Define homogeneous function and harmonic function. 13
- If $u = f(x^2 + 2yz, y^2 + 2zx)$, show that
- $$(y^2 - zx) \frac{\partial u}{\partial x} + (x^2 - yz) \frac{\partial u}{\partial y} + (z^2 - xy) \frac{\partial u}{\partial z} = 0.$$
- 3(a) If $V = (ax + by)^2 - (x^2 + y^2)$, where $a^2 + b^2 = 2$, show that $V_{xx} + V_{yy} = 0$. 10
- 3(b) Find the maximum and minimum values of $12(\log x + 1) + x^2 - 10x + 3$. 13
- 3(c) Find the asymptotes of $x^3 - 2y^3 + xy(2x - y) + y(x - y) + 1 = 0$. 12
- 4(a) If $x \cos \alpha + y \sin \alpha = P$ touch the curve $\frac{x^m}{a^m} + \frac{y^m}{b^m} = 1$ show that 11
- $$(a \cos \alpha)^{\frac{m}{m-1}} + (b \sin \alpha)^{\frac{m}{m-1}} = P^{\frac{m}{m-1}}.$$
- 4(b) Define subtangent and subnormal. Show that for the curve $by^2 = (a + x)^3$, the square of the subtangent varies as the subnormal. 12
- 4(c) Define curvature. Find the radius of curvature of the astroid $x^{2/3} + y^{2/3} = a^{2/3}$ at any point. 12

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Hum 1131

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B. Sc. Engineering 1st Year 1st Term Examination, 2019

MTE 1101

(Mechatronic Systems)

Time: 3 Hours

Total Marks: 210

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

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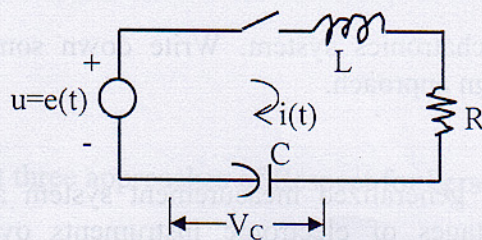
SECTION-A

- 1(a) Explain in brief the theme of Mechatronics Engineering. Mention the difference between conventional and mechatronic approach of a system design. 11
- 1(b) What are the key elements of a Mechatronics system? Demonstrate in brief the concept of mechatronics system with the help of block diagram. 12
- 1(c) Give some example of Mechatronics system. Write down some benefit and demerits of mechatronic design approach. 12
- 2(a) Draw the block diagram of generalized measurement system and explain in details. Mention the advantages of electronic instruments over mechanical instruments. 10
- 2(b) Explain the terms:
(i) Sensitivity, (ii) Reproducibility, (iii) Dead time, and (iv) Loading effect. 08
- 2(c) A voltage has a true value of 1.50 volt. An analog indicating instrument with a scale range of 0 – 2.50 volt shows a voltage of 1.46 volt. What are the values of absolute error and correction? Express the error as a function of true value and full scale deflection. 07
- 2(d) Define relative limiting error. Three resistors have the following ratings :
 $R_1 = 37 \Omega \pm 5\%$, $R_2 = 75 \Omega \pm 5\%$, $R_3 = 50 \Omega \pm 5\%$.
Find the magnitude and limiting error in ohm and percent of the resistance of these resistances connected in series. 10
- 3(a) What is sensor? Why it is necessary in mechatronics? 07
- 3(b) Give some example of commonly used sensors in Robotics. What are the basic elements of a temperature sensor? Compare IR sensor and ultrasonic sensor with respect to object detection. 10
- 3(c) 'A metal detector is a proximity sensor', justify with proper illustration. 10
- 3(d) What will be the contribution of a Mechatronics Engineer to develop a gesture controlled Robot? 08
- 4(a) Design a mechatronic device (Robot) for household activities with necessary actuators. Mention the working area of the robot and name of the actuators. 08
- 4(b) Explain the working principle of a selected actuator and justify its use in the particular device. 15
- 4(c) Describe and differentiate hydraulic, electric and pneumatic actuators with necessary examples. 12

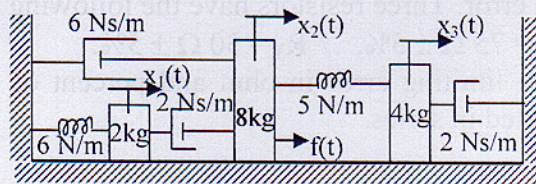
SECTION-B

- 5(a) Define and differentiate analog and digital signal. Mention the domain and range of (i) Black and white photograph, and (ii) Color photograph. 11
- 5(b) How a potentiometer works? A linear resistance POT is 50 mm long and is uniformly wound with a wire having resistance 10 k Ω . Under normal condition, the slider is at center of POT. Find the linear displacement when resistance of POT as measured for two cases is (i) 3850 Ω and (ii) 7560 Ω . 12
- 5(c) Deduce the equation of maximum sensitivity of a Wheatstone bridge. 12

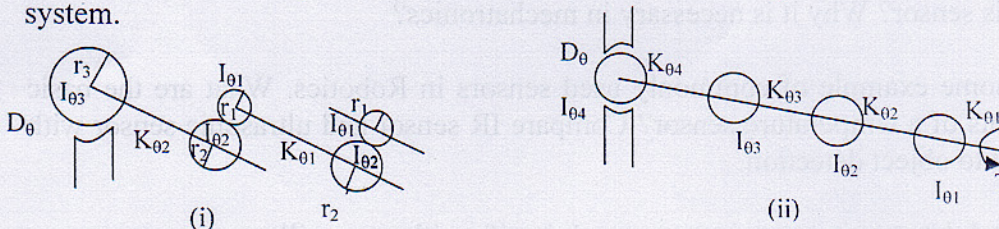
- 6(a) Define control system. Describe open loop and closed loop control system block diagram with example. 11
- 6(b) What are the methods to describe a system? Find the state space model and transfer function of a RLC circuit shown in figure. Assume capacitor voltage as the output. 14



- 6(c) What are signal conditioning and data acquisition? Explain their role in mechatronics system. 10
- 7(a) Define the concept of analogous system. List the analogous quantities between rotational translational mechanical system and hydraulic-electrical system. 11
- 7(b) Find the analogous electrical network for the following mechanical translational system. Also write down the system equation. 12



- 7(c) Draw the $f - i$ analogous electric circuit for the following mechanical rotational system. 12



- 8(a) Explain how can control the position of Robotic arm automatically. 10
- 8(b) Comparing the lifestyle over few decades, it can be said that application of mechatronic systems are increasing rapidly in our daily house hold and medical area. – Justify. 12
- 8(c) Forecast and design a mechatronic system that will be used after 2040. Explain its technical details like sensors, actuators, control systems, etc. 13