

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 1st Year 1st Term Examination, 2022

Ch 1131

(Chemistry)

Time: 3.00 Hrs.

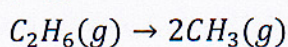
Total Marks: 210

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) What is meant by order of a reaction? Derive an expression for rate constant of 2nd order reaction. 13
- 1(b) How does rate of a reaction vary with temperature? What is Arrhenius equation? 12
- 1(c) The decomposition of ethane (C₂H₆) to methyl radicals is a first order reaction with a rate constant of $5.36 \times 10^{-4} \text{ s}^{-1}$ at 700° C. 10



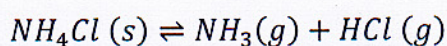
Calculate the half-life of the reaction in minutes.

- 2(a) Define homogeneous equilibrium and heterogeneous equilibrium. Give examples of each. 10
- 2(b) Deduce the relationship between K_P and K_C. When K_P will be equal to K_C? 12
- 2(c) "Chemical equilibrium is a dynamic process." Justify this statement. 05
- 2(d) Consider the following equilibrium at 395 K: 08



The partial pressure of each gas is 0.265 atm. Calculate K_P and K_C for the reaction.

- 3(a) Draw the phase diagram of water. Show the various zone with degree of freedoms. 13
- 3(b) What do you mean by eutectic? What is the eutectic composition of Pb-Ag system? Give one application of eutectics. 09
- 3(c) In the dissociation of ammonium chloride in vacuum, the following equilibrium occurs: 09



How many number of phases, components and degrees of freedom are available in this equilibrium?

- 3(d) What is the condensed phase rule? 04
- 4(a) What are colligative properties? Discuss some practical applications of boiling point elevation and freezing point depression of solutions. 12
- 4(b) Classify solution based on the physical state of solute and solvent. 11
- 4(c) Draw pressure vs temperature diagram of non-volatile solute in solvent and show the effect on freezing point and boiling point. 12

SECTION-B

- 5(a) Define resonance. What are the evidences of resonance? 09
- 5(b) Draw the molecular orbital diagram of N₂²⁻ and answer the followings: 16
- (i) Explain HOMO, LUMO and SOMO and show them in the diagram.
 - (ii) Illustrate the magnetic property of the molecule.
 - (iii) Find out the band order of the molecule.

5(c)	What are the limitations of Lewis dot structure and valence bond theory?	10
6(a)	What is hydrogen bonding? How do intermolecular and intramolecular H-bonding influence the physical properties of the components?	10
6(b)	How will you prepare: (i) Silica gel (ii) Silicone Polymer and (iii) Silicon	09
6(c)	Define Silicate. Draw the structure of Cyclic and Cross-Linked Silicone.	09
6(d)	What is bond order? Write down the conditions for effective combination of atomic orbital to form molecule.	07
7(a)	Construct an electrochemical cell. Explain the working principle of it with half-cell reactions.	10
7(b)	The standard reduction potential of Zn/Zn^{2+} and Ag/Ag^+ electrodes are -0.76 V and 0.08 V respectively. Calculate the emf of the cell: $Zn/Zn^{2+}(0.0001M) \parallel Ag^+(0.1M)/Ag$	07
7(c)	What is corrosion? Discuss the mechanism of underwater corrosion.	10
7(d)	Define threshold value. "SO ₂ and Charcoal powder make the environment highly corrosive". Why?	08
8(a)	What are the differences between nuclear reaction and chemical reaction?	08
8(b)	Explain the following terms: (i) Magic Number (ii) Nuclear fusion and (iii) Nuclear isomer	09
8(c)	Define binding energy of a nucleus. Explain with the help of binding energy curve, the stability of a nuclei.	11
8(d)	How will you apply radioactive atom in reaction mechanism?	07

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EEE 1131

(Electrical Circuits)

Time: 3.00 Hrs.

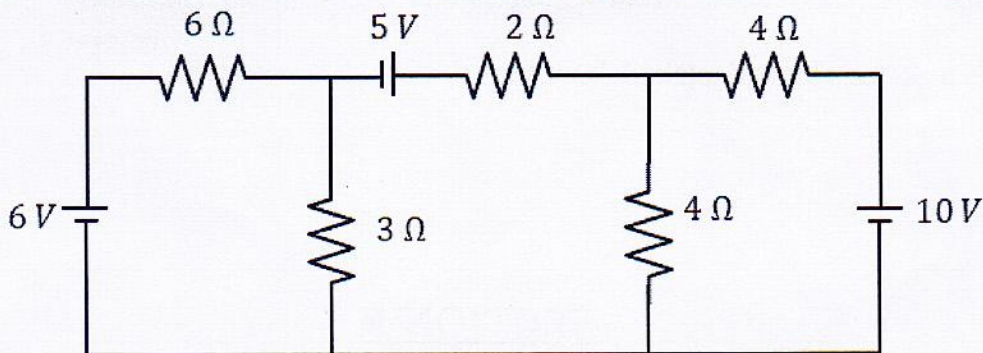
Total Marks: 210

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

1(a) Define node, supernode, and linear bilateral element. 09

1(b) Find all the branch currents using nodal analysis for the circuit shown in the figure. 15

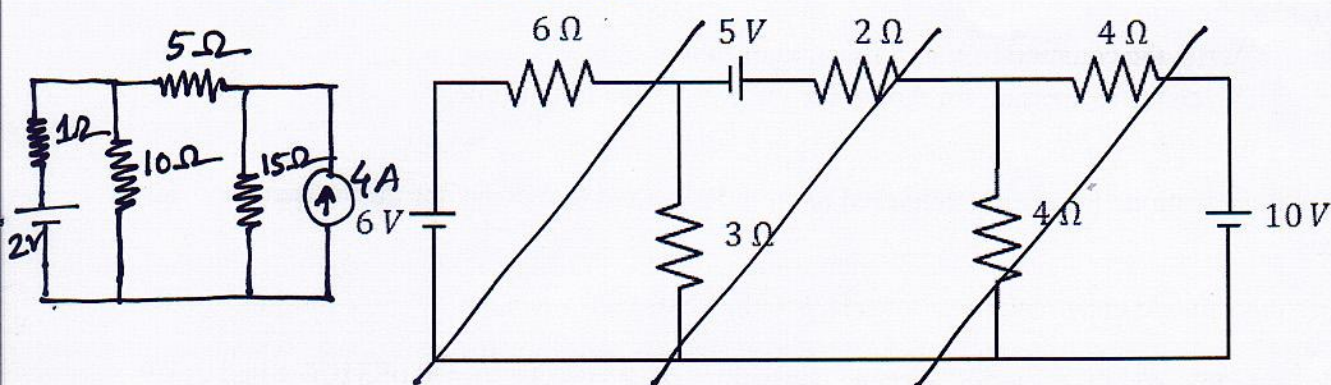


1(c) Deduce the condition for maximum power transmission and find the equation for maximum power. 11

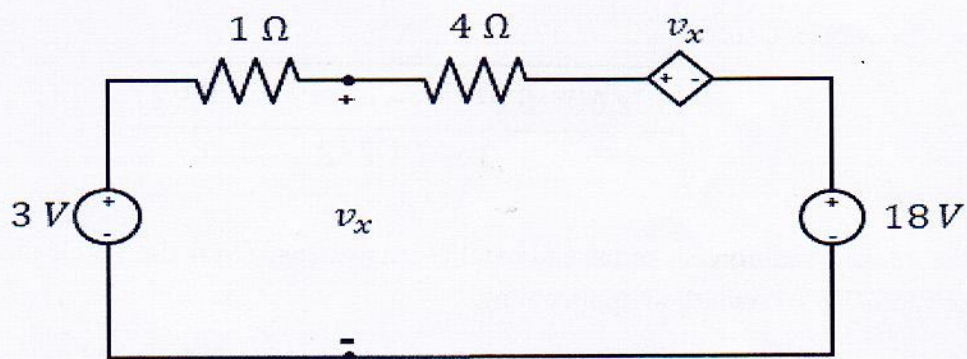
2(a) Express the resistance of delta network to star or Wye network. 10

2(b) State and explain Ohm's law, KVL and KCL. 12

2(c) State superposition theorem. Using the theorem, find the current through 10Ω resistance of the circuit shown in the figure. 13

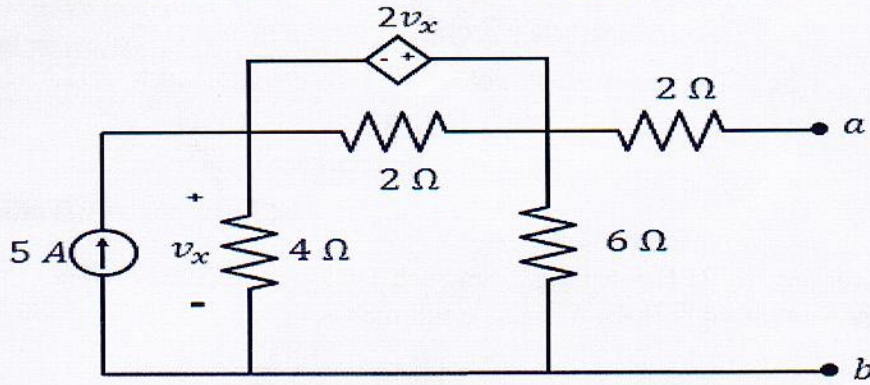


3(a) Find v_x in the following figure using source transformation. 10



3(b) Find the Thevenin equivalent circuit in the following figure at terminals a-b.

15



3(c) Define protective relay. Explain the working principle of a trip circuit.

10

4(a) What are the differences between electric circuit and magnetic circuit? Define (i) Magnetic flux density (ii) Magnetic field intensity and (iii) Reluctance.

15

4(b) State and explain the circuital form of Ampere's Law.

10

4(c) What is hysteresis loss? Explain B-H curve.

10

SECTION-B

5(a) What is phase? Find the angle of phase difference between $v = 100 \cos(\omega t - 30^\circ)$ and $i = -10 \sin(\omega t - 60^\circ)$. Which wave lags?

05

5(b) Define impedance. Derive the equation of impedance of a series RC branch.

10

5(c) A voltage $v = -150 \sin 377t$ is applied to a particular circuit element and it is found $i = 10 \cos 377t$. Make a sketch of v and i waves. Find the nature and magnitude of the circuit parameter.

10

5(d) A current $i = 10 \cos 157t$ amperes flows in an RL circuit containing $R = 15\Omega$ and $L = 0.0637$ henry.

10

(i) Write the equation of v as a function of time.

(ii) Write the expression for the power wave as a function of time.

6(a) Deduce the equations for energy delivered to an inductor and to a capacitor during quarter cycle.

10

6(b) Deduce the value of crest factor and form factor of a sinusoidal wave.

08

6(c) 110 V are applied to a series circuit consisting of $R = 8\Omega$, $L = 0.0531 H$ and $C = 189.7 \mu F$. If $f = 60 Hz$, Calculate current, Power, Power factor, VAR, Reactive factor and VA. Also calculate the voltage drop across each element.

10

6(d) Find all possible roots of

07

$$\sqrt[4]{\frac{10 \angle 60^\circ \cdot 5 e^{j 45^\circ} (-4.047 - j 5.92)}{1 - j 1.732}}$$

7(a) What are the conditions of series and parallel resonances? Draw the vector diagram of each resonance. Write down their applications.

13

7(b) Show that maximum value of V_L occurs after resonance and $L = C(R^2 + X_C^2)$, where symbols have their usual meanings.

12

- 7(c) Explain the two wattmeter method of power measurement of a balanced 3 – ϕ load with necessary vector diagram. 10
- 8(a) Determine the relation between line voltage and phase voltage of a 3 – ϕ balanced Wye and delta system. 10
- 8(b) Given, $V_L = 220\text{ V}$ in a balanced 3 – ϕ system and $R = 6\Omega$, $X_L = 8\Omega$ in each phase. Find the line current, power per phase and total power. 10
- 8(c) Explain power factor correction and define it. Why power factor correction is necessary? 06
- 8(d) A 5 hp motor with a 0.6 lagging power factor and an efficiency of 92% is connected to a 208 V, 60 Hz supply. 09
- (i) Establish the power factor triangle for the load.
 - (ii) Determine the power factor capacitor that must be placed in parallel with the load to raise the power factor to unity.
 - (iii) Determine the change in supply current from the uncompensated to compensated system.

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 1st Year 1st Term Examination, 2022

Hum 1131

(Sociology and Engineering Ethics)

Time: 3.00 Hrs.

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 phenomenon.” Explain this view with example. 10
- 1(b) Write down the contribution of August Comte to the development of sociology as a separate science. 15
- 1(c) What are the importance of studying sociology for the students of mechatronics Engineering? 10
- 2(a) Define society. Explain different types of society. 10
- 2(b) What is social structure? Discuss the role of different elements of social structure with examples. 10
- 2(c) Explain with examples how social stratification is done in your society. 15
- 3(a) What is socialization? How does culture influence on socialization and personal development of a human being? 20
- 3(b) Discuss about social relationship. Why we have to be more social in this modern age? 15
- 4(a) Find out the barriers of industrialization in Bangladesh. 10
- 4(b) Elucidate the major urban social problems in our society. 15
- 4(c) What are the agencies of social change? Explain their roles with examples. 10

SECTION-B

- 5(a) Define the engineering ethics. Explain the principles of ethics for the engineers. 15
- 5(b) What is the fundamental moral concept in ethics – the right or the good? Explain. 10
- 5(c) What are the factors influence engineering decision? 10
- 6(a) Explain the necessity of the code of ethics. Write down some IEEE fundamental codes of ethics. 10
- 6(b) “My right is other’s duty and Other’s right is my duty.” Describe this elaborately. 10
- 6(c) Elaborately explain about utilitarianism. Why this theory so effective in this egoistic period? 15
- 7(a) What is science of ultimate good? - Discuss it. 10
- 7(b) Can ethics enrich your consciousness? Why it is essential for all human being? 15
- 7(c) Discuss some professional characteristics of a good engineer. 10
- 8(a) Define moral judgement. Explain various objectives of moral judgement. 15
- 8(b) Show the approaches of respect for persons. 10
- 8(c) Explain the impact of globalization for engineering ethics. 10

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B.Sc. Engineering 1st Year 1st Term Examination, 2022

Math 1131

(Calculus and Geometry)

Time: 3.00 Hrs.

Total Marks: 210

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

- 1(a) Find the Cartesian and Cylindrical polar co-ordinates of the point $(14, \frac{\pi}{6}, \frac{5\pi}{3})$. 10
- 1(b) Find the equation to the right circular cylinder of radius 2 whose axis passes through (1,2,3) and has d, cosines proportional to 2, -3, 6. 12
- 1(c) Show that the acute angle between any two diagonals of a cube is $\cos^{-1}(\frac{1}{3})$. 13
- 2(a) Find the angle between the plane $5x - 4y + 3z = 5$ and the straight line $2x + 4y - 2z + 3 = 0 = 4x - 2y + 6z + 5$. 10
- 2(b) A variable plane is at a constant distance P from the origin and meets the axes in A, B, C. Find the locus of the centroid of the tetrahedron OABC. 11
- 2(c) Find the length and equation of shortest distance between the lines $\frac{x-3}{3} = \frac{y-8}{-1} = \frac{z-3}{1}$ and $\frac{x+3}{-3} = \frac{y+7}{2} = \frac{z-6}{4}$. 14
- 3(a) Find the distance of the point (1, -2, 3) from the plane $x - y + z = 5$ measured parallel to the line $x - 4y + 2z + 6 = 0 = 3x + y - 4z$. 13
- 3(b) Reduce the equation $x^2 + 4xy + y^2 - 2x + 2y - 6 = 0$ to the standard form and identify the conic. 17
- 3(c) Examine that the straight lines $\frac{x+4}{5} = \frac{y-1}{-3} = \frac{z-3}{1}$ and $3x - 2y + 13 = 0 = y + 3z - 26$ are perpendicular or not. 05
- 4(a) Evaluate $\int_0^{\frac{\pi}{2}} \frac{\sqrt{\tan x}}{1+\sqrt{\tan x}} dx$ 10
- 4(b) Evaluate $\int_0^{\frac{\pi}{2}} \frac{dx}{3+2\cos x}$ 11
- 4(c) Find the reduction formulas of $\int \cos^m x \cos nx dx$ and hence find the value of $\int_0^{\frac{\pi}{2}} \cos^3 x \cos 2x dx$. 14

SECTION-B

- 5(a) Define continuous function at a point. Discuss the continuity and differentiability of the function $f(x) = |x + 4| + |x - 3|$ at $x = -4$ 13
- 5(b) Differentiate $(\cos^{-1} x)^{\sin x}$ with respect to $(\sin x)^{\ln x}$ 10

- 5(c) State Rolle's theorem. Verify mean value theorem for the function 12
 $f(x) = (x + 2)(x + 1)(x - 2)$ in $-1 \leq x \leq 3$
- 6(a) If $y = \tan^{-1} \frac{x}{a}$, Find y_n 12
- 6(b) If $u = f\left(\frac{y-x}{xy}, \frac{z-y}{zy}\right)$, then find the value of $x^2 \frac{\partial u}{\partial x} + y^2 \frac{\partial u}{\partial y} + z^2 \frac{\partial u}{\partial z}$ 12
- 6(c) Find the value of $\sin 31^\circ$ by using Taylor's theorem. 11
- 7(a) Find the values of a and b such that $\lim_{x \rightarrow 0} \frac{x(1+a \cos x) - b \sin x}{x^3} = 1$ 12
- 7(b) Define inflection point of a function. If exist, then find the inflection point for the function 10
 $f(x) = 4x^3 - 12x^2 - 20x + 30$
- 7(c) Find the angles of intersection of the two curves $x^2 = 4y$ and $y(x^2 + 4) = 8$ 13
- 8(a) Find the point of the curve $y = 2x^2 - 3x - 2$ at which the normal is parallel to the straight line $x + 9y - 5 = 0$. Also find the equation of the normal at that point. 12
- 8(b) Find all possible asymptotes for the curve $(x^2 - 4x - 5)(y + 3) + x^2 + 2x - 5 = 0$ 12
- 8(c) Find the radius of curvature of the curve $y = xe^{-x}$ at its maximum point. 11

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MTE 1101

(Mechatronic Systems)

Time: 3.00 Hrs.

Total Marks: 210

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

- 1(a) Describe in brief the basic components of a mechatronic system. How can a mechatronics engineer contribute to achieve Bangladesh govt. vision-2041? - Explain. 15
- 1(b) Give some practical household examples of a mechatronic system. Also mention the major advantages of mechatronic design approach over conventional approach. 10
- 1(c) Suppose your voltmeter shows zero error in instrumentation lab. What type of error is this? Make a list of the sources and remedies to this error. 10
- 2(a) Make a short note on smart sensor. Describe its uses in traffic monitoring system. 08
- 2(b) "A metal detector is a proximity sensor." Justify the statement. 08
- 2(c) What is LVDT? Describe the construction and working principle of a LVDT. Also mention its advantages and disadvantages. 13
- 2(d) Differentiate between open loop system and closed loop system. Give some examples of them. 06
- 3(a) "Potentiometer is a displacement type sensor."- Justify. Also describe the principle of operation of a potentiometer. Mention some of its merits and demerits with applications. 15
- 3(b) Define filtering in signal conditioning. Describe the ideal characteristics curve of different types of filters. 12
- 3(c) Write down the analogy between human control and computer control. 08
- 4(a) Explain the components used in analog to digital conversion. Also describe the procedure in detail. 10
- 4(b) Draw the block diagram and explain the function of various components of a data acquisition system. 10
- 4(c) Describe the working of dot matrix printer with necessary figures. 07
- 4(d) Prove that the change in output voltage of a Wheatstone bridge is approximated to 08

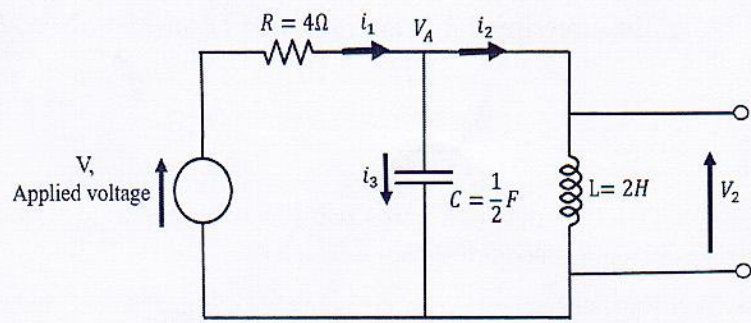
$$\delta V_0 \approx V_S \left(\frac{\delta R_1}{R_1 + R_2} \right), \text{ where the symbols have their usual meanings.}$$

SECTION-B

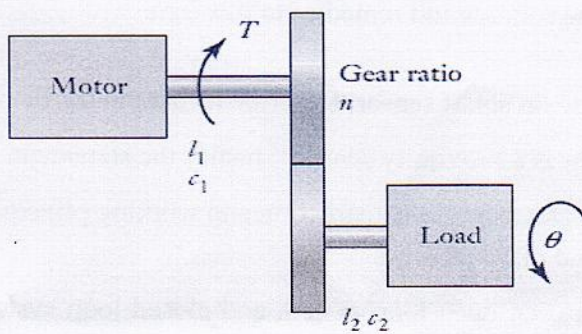
- 5(a) Why are Linearized system models important? Show that the system described by the following equation is linear. 13

$$\frac{dy}{dt} + 3y(t) = x(t)$$

- 5(b) For the RLC circuit shown in figure, Find the mathematical model when the input is applied voltage, V and output is voltage across the inductor, V_2 . 12



- 5(c) Draw the block diagram of a generalized measurement system. How a smartphone can convert our speech into text. 10
- 6(a) Develop and explain a hydraulic system where liquid flow rate changes only slowly. Also find out the mathematical model of the system. 10
- 6(b) Derive the differential equation for a motor driving a load through a gear system as given in figure, which relates the angular displacement of the load with time. 10



- 6(c) What will be (i) the undamped angular frequency, (ii) the damping factor, (iii) the damped angular frequency, (iv) the rise time, (v) the peak time, (vi) the percentage maximum overshoot, (vii) the 2% settling time, and (viii) the 2% no. of oscillations for a system which gave the following differential equation for a step input y ? 15

$$\frac{d^2x}{dt^2} + 5\frac{dx}{dt} + 16x = 16y$$

- 7(a) Define control system. Write down the steps of designing a feedback control system for production process. 10
- 7(b) What are the main differences between natural and forced responses? Find out the natural and forced response equations for a standard first order system. 13
- 7(c) Suppose, you have a translational mechanical (Spring-dashpot-man) system. What are the different ways you can represent the system?- Explain. 12
- 8(a) Define smart actuators. Describe the benefits and applications of smart actuators. 10
- 8(b) "The speed of a DC motor is directly proportional to back emf and inversely proportional to flux per pole." Justify the statement. 09
- 8(c) Why are stepper motors used in a robotic arm? Describe the advantages and disadvantages of stepper motors with their application fields. 10
- 8(d) Write short notes on : (i) Solenoid (ii) Fluid power actuator 06