Semester: I	Department of Chemistry	AY: 2026-27
Course Code: 1BCHEE102	Course Name: Applied Chemistry for Emerging Electronics and Futuristic Devices	

Question Bank

Module 1 – Materials for Energy Devices

Q.No	Question	Marks	CO's	L
1	What are semiconductors? Differentiate between organic and inorganic semiconductors with examples.	6	CO1	L2
2	Explain n-type and p-type semiconductor materials with suitable organic and inorganic examples.	6	CO1	L2
3	Explain the working principle of organic photovoltaics using P3HT as donor and PCBM as acceptor. Mention its applications.	7	CO1	L2
4	What is a battery? Classify batteries into primary, secondary and reserve batteries with one example each.	6	CO1	L1
5	Explain the following battery characteristics: (i) Capacity (ii) Power density (iii) Shelf life (iv) Cycle life.	6	CO1	L2
6	Describe the construction and working of a lithium-ion battery with cell reactions. List its advantages in EV applications.	8	CO1	L2
7	Explain the construction and working of an ultra-small asymmetric supercapacitor and its applications in IoT/wearable devices.	7	CO1	L2
8	Describe the construction and working principle of a solar photovoltaic (PV) cell. Mention its advantages and limitations.	7	CO1	L2
9	Explain the working principle and applications of MEMS-based energy harvesters.	6	CO1	L2
10	Compare lithium-ion batteries and supercapacitors with respect to energy density, power density and cycle life. Justify which is better suited for wearable devices.	6	CO1	L4

Module 2 – Nano and Quantum Dot Materials

Q.No	Question	Marks	CO	RBT
1	What are nanomaterials? Explain the size-dependent properties of nanomaterials with respect to surface area and catalytic activity.	6	CO1	L2
2	Explain the size-dependent optical properties and electrical conductivity of nanomaterials.	6	CO2	L2
3	Describe the synthesis of TiO_2 nanoparticles by the sol-gel method. Mention its uses in sensor applications.	7	CO2	L2

Q.No	Question	Marks	CO	RBT
4	What are quantum dots? Explain the different types of quantum dots.	6	CO1	L1
5	Explain the optical and electronic properties of quantum dots with reference to the quantum confinement effect.	6	CO2	L2
6	Describe the synthesis and properties of silicon-based quantum dots by the sol-gel method.	7	CO2	L2
7	Explain the synthesis of CdSe quantum dots by the hot injection method and their applications in optoelectronic devices.	8	CO2	L2
8	Explain the synthesis and properties of chitosan-carbon quantum dot hydrogel and its applications in flexible and wearable electronics.	7	CO2	L2
9	Describe the synthesis of graphene quantum dots by the citric acid method. Mention their properties and applications in emerging electronics.	7	CO2	L2
10	Differentiate between inorganic and organic quantum dot materials. Justify why organic QDs are preferred for wearable electronics.	6	CO2	L4

Module 3 – Functional Polymers and Hybrid Composites in Flexible Electronics

Q.No	Question	Marks	CO	RBT
1	Explain the basic principle and working of lithography for micro-patterned copper deposition.	7	CO3	L2
2	Describe the synthesis and properties of PDMS (polydimethylsiloxane). Mention its uses in e-skin and RFID applications.	8	CO3	L2
3	Explain the synthesis of polyaniline and its conduction mechanism.	7	CO3	L2
4	What are conducting polymers? Explain the applications of polyaniline in electronic devices.	5	CO2	L1
5	Define number average and weight average molecular weight of polymers. Write their expressions and explain their significance.	6	CO2	L2
6	A polymer sample contains 100 molecules of molecular mass 1×10^3, 200 molecules of 1×10^4 and 200 molecules of 1×10^5 g/mol. Calculate the number average and weight average molecular weights.	5	CO3	L3
7	In a polymer sample, 30% of the molecules have molecular mass 20,000, 40% have 30,000 and the rest have 60,000 g/mol. Calculate $\bar{M}n$ and $\bar{M}w$.	5	CO3	L3
8	Describe the synthesis and properties of polyvinylidene fluoride (PVDF) and its applications in E-nose devices.	7	CO3	L2
9	Explain the synthesis (ultrasonication method) and properties of epoxy resin–magnetite (Fe_3O_4) composite for sensor applications.	7	CO3	L2
10	Describe the synthesis and properties of Kevlar Fiber Reinforced Polymer (KFRP) and its applications in smart electronic devices.	6	CO3	L2

Module 4 – Electrode System and Electrochemical Sensors

Q.No	Question	Marks	CO	RBT
1	What are electrodes? Mention the types of electrodes and give an overview of the Nernst equation.	7	CO2	L2
2	What is a reference electrode? Explain the construction, working and applications of the calomel electrode.	7	CO2	L2
3	Define ion selective electrode. Explain the construction and working of the glass electrode.	7	CO2	L2
4	Explain the determination of pH of a solution using a glass electrode.	6	CO3	L3
5	What is a concentration cell? Explain its construction and working with a suitable example.	6	CO3	L2
6	Calculate the EMF of the cell Cu | Cu^{2+} (0.01 M) || Cu^{2+} (0.1 M) | Cu at 298 K.	4	CO3	L3
7	The EMF of the concentration cell Ag | Ag^{+} (C_1) || Ag^{+} (0.1 M) | Ag is 0.0591 V at 298 K. Calculate the value of C_1.	4	CO3	L3
8	Explain the principle and instrumentation of colorimetric sensors and their application in the estimation of copper in PCBs.	7	CO3	L2
9	Explain the principle and instrumentation of potentiometric sensors and their application in the estimation of iron in steel.	7	CO3	L2
10	Explain the principle of conductometric sensors and their application in the estimation of an acid mixture, with a neat titration curve.	7	CO3	L3

Module 5 – Corrosion Science and E-waste Management

Q.No	Question	Marks	CO	RBT
1	What is corrosion? Explain the electrochemical theory of corrosion taking iron as an example.	7	CO3	L2
2	Explain differential metal corrosion with reference to electronic circuits.	6	CO3	L2
3	Explain differential aeration corrosion with reference to (i) waterline corrosion and (ii) pitting corrosion.	7	CO3	L2
4	Explain the following corrosion control methods: (i) Galvanization (ii) Anodization.	6	CO3	L2
5	What is cathodic protection? Explain the sacrificial anode and impressed current methods.	7	CO3	L2
6	Define corrosion penetration rate (CPR) and mention its importance. A steel sheet of area 100 in^2 exposed to air for one year showed a weight loss of 485 g. If the density of steel is 7.9 g/cm^3, calculate CPR in mpy and mm/y.	8	CO3	L3

Q.No	Question	Marks	CO	RBT
7	What is metal finishing? Explain its technological importance and differentiate between electroplating and electroless plating.	6	CO3	L2
8	Explain the electroplating of chromium for hard and decorative coatings.	7	CO3	L2
9	Explain the electroless plating of copper on PCBs.	6	CO3	L2
10	What is e-waste? Mention its sources, need for management and effects on environment and human health. Explain the extraction of gold from e-waste by the bioleaching method.	8	CO3	L2

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Answer Key for Numerical Problems

Question	Solution
Module 3, Q6	$\Sigma n = 500$; $\Sigma nM = 2.21\times10^{7}$; $\Sigma nM^2 = 2.0201\times10^{12}$. $\bar{M}n = \Sigma nM/\Sigma n = 44{,}200$ g/mol; $\bar{M}w = \Sigma nM^2/\Sigma nM \approx 91{,}407$ g/mol.
Module 3, Q7	$\bar{M}n = (0.3\times20000)+(0.4\times30000)+(0.3\times60000) = 36{,}000$ g/mol; $\bar{M}w = \Sigma xM^2/\Sigma xM = 1.56\times10^{9}/36000 \approx 43{,}333$ g/mol.
Module 4, Q6	$E = (0.0591/n)\log(C_2/C_1) = (0.0591/2)\log(0.1/0.01) = 0.0296$ V.
Module 4, Q7	$0.0591 = (0.0591/1)\log(0.1/C_1) \Rightarrow \log(0.1/C_1) = 1 \Rightarrow C_1 = 0.01$ M.
Module 5, Q6	CPR (mpy) = $534W/(DAT) = (534\times485000)/(7.9\times100\times8760) \approx 37.4$ mpy. CPR (mm/y) = $87.6W/(DAT)$ with A = 645.16 cm² = $(87.6\times485000)/(7.9\times645.16\times8760) \approx 0.95$ mm/y. (W in mg, D in g/cm³, A in in² or cm², T in h)

***Note:**

1. All modules should contain a minimum of **10** questions each and the total number of questions must be **50**.
2. Questions can carry marks of 06, 07, 08, 09, 10 and for problems: 04 or 05.
3. Follow the RBTL as per the keywords used to frame the questions.
4. Maintain the Course Outcomes (COs) as per the syllabus.
5. M: Marks, L: RBTL, C:COs.

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