Semester: I	Department of Chemistry	AY: 2026-27
Course Code: 1BCHES102	Course Name: Applied Chemistry for Smart Systems	

Question Bank

Module 1 – Functional Materials for Memory and Display Systems

Q.No	Question	Marks	CO's	L
1	What are organic semiconductors? Explain the types of organic semiconductors used in memory devices with examples.	6	CO1	L2
2	Explain p-type (pentacene) and n-type (perfluoropentacene) organic semiconductors with their structures.	6	CO1	L2
3	Differentiate between organic and inorganic memory devices.	5	CO1	L2
4	Explain the construction, working and advantages of a pentacene semiconductor chip.	7	CO1	L2
5	What is Resistive RAM (ReRAM)? Describe the synthesis of TiO_2-RAM nanomaterial by the sol-gel method. Mention its properties and applications.	8	CO1	L2
6	What are liquid crystals? Explain the classification of liquid crystals with examples.	6	CO1	L2
7	Explain the properties and applications of liquid crystals in display systems.	6	CO1	L2
8	Explain the construction, working principle and applications of Light Emitting Diodes (LEDs).	6	CO1	L2
9	Explain the construction, working principle and applications of OLEDs. How do AMOLEDs differ from OLEDs?	8	CO1	L2
10	Explain the construction, working principle and applications of Quantum Light Emitting Diodes (QLEDs). Compare QLEDs with OLEDs.	7	CO1	L4

Module 2 – Quantum Materials and Polymers

Q.No	Question	Marks	CO	RBT
1	What are quantum dots? Explain the size-dependent properties of quantum dots: quantum confinement effect, surface-to-volume ratio and band gap.	7	CO2	L2
2	Describe the synthesis of CdSe quantum dots by the wet chemical method. Mention their applications.	7	CO2	L2
3	Explain the construction, working principle and applications of quantum dot sensitized solar cells (QDSSCs).	7	CO2	L2
4	Define number average and weight average molecular weight of polymers. Write their expressions.	4	CO2	L1
5	In a polymer sample, 25% of the molecules have molecular mass 10,000, 50% have 20,000 and 25% have 40,000 g/mol. Calculate $\bar{M}n$ and $\bar{M}w$.	5	CO2	L3
6	A polymer sample contains 50 molecules of molecular mass 5,000, 100 molecules of 15,000 and 50 molecules of 50,000 g/mol. Calculate the number average and weight average molecular weights.	5	CO2	L3
7	Explain the structure-property relationship of polymers with respect to crystallinity, strength, elasticity and chemical resistivity.	8	CO2	L2
8	Describe the synthesis and properties of nylon-6,6. Mention its advantages in 3D printing applications.	6	CO2	L2
9	Describe the synthesis and properties of CPVC and PMMA and their uses in device applications.	8	CO2	L2
10	What are conducting polymers? Explain the synthesis of polyaniline, its conduction mechanism and engineering applications.	8	CO2	L2

Module 3 – Sustainable Energy Systems

Q.No	Question	Marks	CO	RBT
1	Give a basic overview of the Nernst equation. What is a concentration cell? Explain its construction and working.	7	CO2	L2

Q.No	Question	Marks	CO	RBT
2	Calculate the EMF of the cell Zn | Zn^{2+} (0.005 M) || Zn^{2+} (0.05 M) | Zn at 298 K.	4	CO3	L3
3	The EMF of the cell Cu | Cu^{2+} (0.02 M) || Cu^{2+} (C_2) | Cu is 0.0296 V at 298 K. Calculate C_2.	4	CO3	L3
4	Classify batteries with examples. Explain the construction, working and applications of the lithium-ion battery.	8	CO3	L2
5	Explain the construction and working of a sodium-ion battery for EV applications. Compare it with the Li-ion battery.	7	CO3	L4
6	Explain the construction and working of an ultra-small asymmetric supercapacitor and its applications in IoT/wearable devices.	7	CO3	L2
7	What are fuel cells? Differentiate between a fuel cell and a battery.	6	CO2	L2
8	Explain the construction, working principle, applications and limitations of the solid-oxide fuel cell (SOFC).	7	CO3	L2
9	Explain the construction, working principle, applications and limitations of the solar photovoltaic (PV) cell.	7	CO3	L2
10	Explain the production of green hydrogen by photocatalytic water splitting using TiO_2 catalyst. Mention its advantages.	7	CO3	L2

Module 4 – Sensors and Corrosion Science

Q.No	Question	Marks	CO	RBT
1	Define transducer, actuator and sensor with examples.	5	CO2	L1
2	Explain the principle and construction of a conductometric sensor and its application in the estimation of an acid mixture, with a titration curve.	7	CO3	L3
3	Explain the principle and instrumentation of a colorimetric sensor and its application in the estimation of copper in PCB.	7	CO3	L2

Q.No	Question	Marks	CO	RBT
4	Explain the principle and construction of electrochemical gas sensors and their application in detecting NOx and SOx in air samples.	7	CO3	L2
5	Explain the principle, construction and working of a biosensor for the detection of glucose in biofluids.	7	CO3	L2
6	What is corrosion? Explain the electrochemical theory of corrosion taking iron as an example.	7	CO3	L2
7	Explain differential metal corrosion and differential aeration corrosion with reference to waterline and pitting corrosion.	8	CO2	L2
8	Explain corrosion control by (i) galvanization and (ii) anodization.	6	CO3	L2
9	What are vapour corrosion inhibitors? Explain their role in protecting computer circuit boards.	6	CO2	L2
10	Define corrosion penetration rate (CPR). A copper sheet of area 200 cm^2 loses 2.4 g in 30 days. If the density of copper is 8.96 g/cm^3, calculate CPR in mm/y and mpy.	6	CO3	L3

Module 5 – Green Materials and E-Waste Management

Q.No	Question	Marks	CO	RBT
1	What is green chemistry? Explain the properties and applications of green solvents for server heat management.	7	CO2	L2
2	Describe the synthesis and properties of glycerol trioleate ester and its uses in IT infrastructure applications.	7	CO3	L2
3	Explain the green synthesis of ZnO nanoparticles and their uses in magnetic RFID and Internet of Nano Things (IoNT) applications.	8	CO3	L2
4	What are biomaterials? Describe the synthesis and properties of polylactic acid (PLA) and its use in touch screen applications.	7	CO3	L2
5	Describe the synthesis and properties of polyethylene glycol (PEG) and its uses in touch screen applications.	6	CO3	L2

Q.No	Question	Marks	CO	RBT
6	Describe the synthesis and properties of alginate hydrogel and its uses in Brain-Computer Interfaces (BCIs).	7	CO2	L2
7	What is e-waste? Explain the sources and composition of e-waste.	6	CO2	L1
8	Explain the effects of e-waste on the environment and human health.	6	CO2	L2
9	Explain the role of artificial intelligence in e-waste management.	6	CO3	L2
10	Explain the extraction of gold from e-waste by the bioleaching method.	7	CO3	L2

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Answer Key for Numerical Problems

Question	Solution
Module 2, Q5	$\bar{M}n = (0.25\times10000)+(0.5\times20000)+(0.25\times40000) = 22{,}500$ g/mol; $\Sigma xM^2 = 6.25\times10^8$, so $\bar{M}w = 6.25\times10^8/22500 \approx 27{,}778$ g/mol.
Module 2, Q6	$\Sigma n = 200$; $\Sigma nM = 4.25\times10^6$; $\Sigma nM^2 = 1.4875\times10^{11}$. $\bar{M}n = 21{,}250$ g/mol; $\bar{M}w = 1.4875\times10^{11}/4.25\times10^6 = 35{,}000$ g/mol.
Module 3, Q2	$E = (0.0591/n)\log(C_2/C_1) = (0.0591/2)\log(0.05/0.005) = 0.0296$ V.
Module 3, Q3	$0.0296 = (0.0591/2)\log(C_2/0.02) \Rightarrow \log(C_2/0.02) = 1 \Rightarrow C_2 = 0.2$ M.
Module 4, Q10	$W = 2400$ mg, $T = 30\times24 = 720$ h. CPR (mm/y) $= 87.6W/(DAT) = (87.6\times2400)/(8.96\times200\times720) \approx 0.163$ mm/y. With $A = 200/6.4516 = 31.0$ in²: CPR (mpy) $= 534W/(DAT) = (534\times2400)/(8.96\times31.0\times720) \approx 6.41$ mpy.

***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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