| CHEM 1001 | Chemistry | L | T | P | C |
|---|---|---|---|---|---|
| Version 1.0 | | 3 | 2 | 0 | 4 |
| Pre-requisites/Exposure | $12^{th}$ level Chemistry | | | | |
| Co-requisites | -- | | | | |

## Course Objectives

Objectives of the course are:

1. To make students familiar with the fundamental concepts of chemistry.
2. To make the students understand the various basic chemical reactions, related calculations and reasoning.
3. To prepare the students for studying advanced subjects with required knowledge of chemistry.

## Course Outcomes

On completion of this course, the students will be able to:

CO1. To know the basic concepts of chemistry w.r.t thermochemical reactions, reaction dynamics, organic reaction, electrolysis, electrochemical reactions, polymers and Nanomaterials
CO2. To explain preparation, properties, mechanism and case based reasoning in various chemical reactions and compounds/materials
CO3. To apply the concepts of chemistry in reaction dynamics, corrosion related problems and selecting suitable fuel for various domestic/industrial applications
CO4. To analyze the results of various analytical/chemical procedures

## Catalogue Description

Chemistry is present everywhere around us. It is existing in everything we see, feel or imagine. It is one of the very fundamental basics behind every structure, building, bridge, refinery and industry. In this course, focus will be on firming the basic knowledge of students about chemistry. Students will learn how to use the concepts correctly through prescribed syllabus. They will be taught various types of fuels. Different processes used to improve the quality of fuels in refineries will also be discussed. Combustion calculations related to oxygen or air required will help them to get an effective fuel:$O_2$ ratio to result in proper and complete combustion. Kinetics will help them to understand the mechanism of reaction. This knowledge will make them able to control the factors to move the reaction in desired direction. Corrosion is based on electrochemical cells. For any engineer, it is quite mandatory to have an understanding to select the suitable metal and also the methods to protect it from decaying. They will also be discussed about various types of polymers and nanomaterials so that they can correlate their properties to their various application areas. Course delivery will be made by classroom teaching, Blackboard, presentations, videos and tutorial classes.

**Course Content**

**Unit I: Fuels & Thermochemistry** **8 lecture hours**

Prerequisite, Thermochemistry, Introduction, Classification of Important properties of a good Fuel, calorific value, determination of calorific value by Bomb calorimeter, combustion and its Calculations, analysis of coal sample by proximate and ultimate analysis, distillation of crude oil, composition of petroleum, renewable energy sources like biodiesel, power alcohol, synthetic petrol etc., Octane number, Cetane number, Isomerization, Dimerization, Aromatization, and cracking

**Unit II: Reaction Dynamics** **9 lecture hours**

Prerequisite, Second (2A & A+B) and third (3A) order reaction, Effect of temperature on reaction rate, Concept of activation energy and energy barrier, Collision theory, Methods of determining order of a reaction, Lindamann Theory, Steady state and equilibrium approximation, Kinetics of complex reactions-reversible and parallel reactions, Kinetics of consecutive and chain reaction. $K_p$, $K_x$, $K_c$ and interrelation between them for equilibrium, types of reaction, Homo and Heterogeneous types of equilibrium reactions, numerical.

**Unit III: Electrochemistry and Corrosion** **6 lecture hours**

Prerequisite, Conductance and its types, Variation of conductance with dilution, Transport number, Determination by Moving Boundary Method, Hittorf's method and Application of Transport number in Batteries, Application of electrochemistry in corrosion, Introduction, Factors affecting corrosion types of Corrosion, Dry theory, Wet theory, Acid theory, prevention of corrosion.

**Unit IV: Organic Chemistry** **8 lecture hours**

Prerequisite, Types of organic reactions, electrophilic addition on (>C=C bond) and nucleophilic addition on (>C=O bond) reaction Elimination- E1 and E2, stereochemistry, Aliphatic nucleophilic substitution-SN1& SN2. Stereochemistry Elimination vs substitution, Aromatic Electrophilic, substitution reaction with energy profile, Halogenation, Nitration, sulphonation and Friedel craft reaction (comparison also), Mono and di substituted aromatic Substitution, Road map problem based on organic reactions, Fischer-Troph's synthesis and Synthesis gas.

**Unit V: Polymers** **6 lecture hours**

Prerequisite, Classification, Copolymers, General properties. Types of polymerization Techniques - Bulk and Solution Types of polymerization techniques- Suspension and Emulsion. Mechanism and kinetics of polymerization (Ionic & free radical) average molecular weight of polymers, Poly dispersity index. Vulcanization, Biodegradable polymers, conducting polymers and plastic hazards.

**Unit VI: Nanomaterials** **3 lecture hours**

Introduction, Effect of size on important properties. Methods of preparation, Bragg's

Equation, BET Surface area, XRD. Application of nano materials.

**Text Books**


1. Bapna, Renu, Engineering Chemistry - New Delhi MacMillan 2010 – 431, ISBN:0230330762.
2. Text book of Engineering Chemistry, By: Chawla, Shashi, BookPublisher: Delhi: Dhanpat Rai, 2014. ISBN 13: 123456755036.
3. Engineering Chemistry, By: Krishnamoorty, P, Publisher: New Delhi: McGraw Hill, 2012, Edition: 1.ISBN: 9780071328753.


**Reference Books**


1. Encyclopedic dictionary of organic chemistry, By Milton, Jules K., Publisher: New Delhi Pentagon Press 2004Description: 208p., ISBN: 818274167--X; 9788182741676.
2. Crude oil chemistry, By: Simanzhenkov, Vasily, BookPublisher: New York: Marcel Dekker, 2003 Description: 409p.ISBN: 082474098.
3. Atkins' physical chemistry, By: Atkins, Peter, Paula, Julio De, BookPublisher: New Delhi Oxford University Press 2014, Edition: 10th. ISBN: 9780198728726; 0198728727.
4. Essentials of Physical Chemistry by Bahl & Tuli, Publisher: S.Chand & Co., ISBN 13: 978-8121929783.
5. Organic Chemistry for engineers, By: Mallick, Abhijit, Book Publisher: New Delhi: Viva Books, 2012, ISBN: 9788130920580.


**Modes of Evaluation: Quiz/Assignment/ Common Class Tests/ Tutorial classes/ Written Examination Scheme:**

| Components | MSE I | IA (30) | | ESE |
|---|---|---|---|---|
| | | CCTs | Tutorials/Assignment/ etc. | |
| Weightage (%) | 20 | 15 | 15 | 50 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Mapping between COs and POs | | |
|---|---|---|
| | **Course Outcomes (COs)** | **Mapped Programme Outcomes** |
| **CO1** | To know the basic concepts of chemistry w.r.t thermochemical reactions, reaction dynamics, organic reaction, electrolysis, electrochemical reactions, polymers and Nanomaterials reactions and compounds/materials | **PO1,3** |
| **CO2** | To explain preparation, properties, mechanism and case based reasoning in various chemical | **PO1,3** |
| **CO3** | To apply the concepts of chemistry in reaction dynamics, corrosion related problems and selecting suitable fuel for various domestic/industrial applications | **PO1,3** |
| **CO4** | To analyze the results of various analytical/chemical procedures | **PO1** |

| | | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual or team work | Communication | Project management and finance | Life-long Learning |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CHEM 1001 | Chemistry | 3 | | 2 | | | | | | | | | |

1=weakly mapped

2= moderately mapped
3=strongly mapped

# Model Question Paper

| | |
|---|---|
| **Name:**<br>**Enrolment No:** | |

**Course: CHEM-1001 – Chemistry**

**Programme: B.Tech. (All Programmes)** **Semester: EVEN-2015-16**

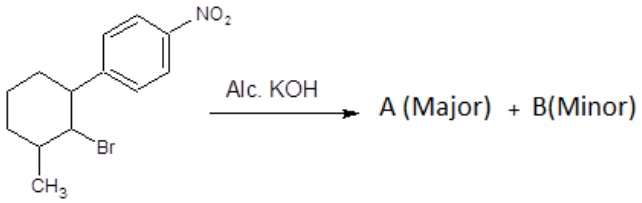
**Time: 03 hrs.** **Max. Marks:100**

**Instructions:**
Attempt any FIVE questions from **Section A** (each carrying 4 marks); all **FIVE Questions** from **Section B** (each carrying 8 marks)**. Section C** is Q No.11 Compulsory & attempt any one from QNo12A & QNo.12B (carrying 20 marks)**.**

**Section A ( attempt all FIVE questions)**

| | | | |
|---|---|---|---|
| 1. | Compute the enthalpy of formation of methyl alcohol using the following bond energy data:<br>$(H-H)=436\frac{kj}{mol}$; $(O=O)=498\frac{kj}{mol}$; $(C_s \rightarrow C_g)=715\frac{kj}{mol}$<br>$(C-H)=415\frac{kj}{mol}$; $(C-O)=356\frac{kj}{mol}$; $(O-H)=463\frac{kj}{mol}$ | **[4]** | **CO1** |
| 2. | For the reaction: $2NO + Cl_2 \rightarrow 2NOCl$ at 300 K, following data are obtained. Write rate law equation. What is the order of the reaction? Also calculate the rate constant. | **[4]** | **CO2** |
| 3. | If iron rod is dipped in pure degassed water, do you expect iron rod to be corroded? Explain with the help of given half-cell potential values:<br>$E^0$ ($Fe^{2+}$/Fe) = -0.44 V and $2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$ ; $E^0$= -0.83 V | **[4]** | **CO3** |
| 4. | What is the distance between the adjacent Miller planes if the first order reflection from X-rays of wavelength 2.29 Å occurs at an angle of 27°? | **[4]** | **CO5** |
| 5. | With reason, arrange the following carbonyl compounds in the decreasing order of their reactivity towards nucleophilic addition reaction. | **[4]** | **CO4** |

| Expt. No. | Initial Concentration (mol $L^{-1}$) | | Initial rates (mol $L^{-1}s^{-1}$) |
|---|---|---|---|
| | [NO] | [$Cl_2$] | |
| 1 | 0.010 | 0.010 | $1.2\times10^{-4}$ |
| 2 | 0.010 | 0.020 | $2.4\times10^{-4}$ |
| 3 | 0.020 | 0.020 | $9.6\times10^{-4}$ |

| | | | |
|---|---|---|---|
| | $CF_3CHO$, $CH_3CHO$, HCHO, $CF_2BrCHO$, $CH_3COCH_3$ | | |
| | **SECTION B (**Attempt all FIVE **Questions)** | | |
| 6. | Show the formation of two products with appropriate mechanism<br>  <br> | **[8]** | **CO4** |
| 7. | A coal sample obtained from a mine was analyzed for various chemical elements and exhibited the following results<br>C = 75%; H =5.2%; N=3.2%; ash 4.5% and rest oxygen.<br>(a) If 1 kg of coal sample is burnt, how much minimum air is required in Kg for its complete combustion.<br>(b) Calculate the net calorific value of the coal sample if its gross calorific value is 7332.18 kcal/kg. Assume that the latent heat of steam is 587 Cal/g. | **[8]** | **CO1** |
| 8. | i) Explain in detail the polymerization technique used to obtain polymer in the form of beads/pearl.<br>ii) Compare bulk and solution polymerization. | **[8]** | **CO5** |
| 9. | Following mechanism has been suggested for the decomposition of $N_2O_5$<br>Overall reaction: $2N_2O_5 \longrightarrow 4NO_2 + O_2$<br>**Mechanism:**<br>$N_2O_5 \xrightarrow{K_1} NO_3 + NO_2$<br>$NO_3 + NO_2 \xrightarrow{K_2} N_2O_5$<br>$NO_3 + NO_2 \xrightarrow{K_3} NO + NO_2 + O_2$<br>$NO_3 + NO \xrightarrow{K_4} 2NO_2$<br>Apply SSA for intermediates and show that<br>$d[NO_2]/dt = 4K_1K_3[N_2O_5]/ (K_2+2K_3)$ | **[8]** | **CO2** |
| 10. | i) Describe five main factors affecting corrosion.<br>ii) Why does silver get tarnish and copper metal develops green coating when exposed to atmosphere? | **[8]** | **CO3** |
| | **SECTION C is Compulsory** | | |

| | | | |
|---|---|---|---|
| 11. | i) A compound 'A' with molecular formula $C_8H_9Br$ reacts with aqueous NaOH to form 'B', which in turn reacts with conc. $H_2SO_4$ to give 'C'. 'C' on reaction with HBr forms 'D', an isomer of 'A'. Infer the structures of 'A', 'B', 'C' and 'D' to complete the reaction sequence and probable mechanism of the conversion A to sB.<br><br>ii) An electrolytic solution of silver nitrate has 1.14 mg in unit gram of solution. After passing current through the solution, the concentration of anode solution was 39.70 mg of silver in 20.10 gram solution. The amount of silver deposited in voltameter attached in series was 32.10 mg of silver. Calculate the transport number of $Ag^+$ and $NO_3^-$ ?<br>iii) Describe the principle of moving boundary method and explain how to calculate the transport number of cation using necessary diagrams and formula. | **[20]** | **CO3 & CO4** |
| 12. A. | **i)** The reaction between gaseous oxygen and sulfur dioxide, is an important stage for synthesis of $H_2SO_4$ at industrial level: $2SO_{2(g)}+O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ A mixture of $SO_2$ and $O_2$ was maintained at 527 $^0$C until the system reached equilibrium. The homogeneous equilibrium mixture contained the $5.0\times10^{-2}$ M of $SO_3$, $3.5\times10^{-}$ M of $O_2$ and $3.0\times10^{-}$ M $SO_2$. Calculate $K_c$ and $K_p$ for the above reaction at $527^0$C. (Given R = 8.314 J $K^{-1}mol^{-1}$).<br>(ii) In a polymer there are 100 molecules of molecular weight 100, 200 molecules of molecular weight 1000 and 300 molecules of molecular weight 10000. Find number average molecular weight ($M_n$), weight average molecular weight ($M_w$) and poly dispersity index (PDI).<br>(iii) For the strong electrolytes NaOH, NaCl and $BaCl_2$, the molar ionic conductance at infinite dilution are 248.1 x $10^{-4}$, 126.5 x $10^{-4}$ and 280 x $10^{-4}$ $Sm^2mol^{-1}$, respectively. Calculate molar ionic conductance at infinite dilution for $Ba(OH)_2$. | **[20]** | **CO2, CO3 & CO5** |
| 12. B. | **(i)** Explain the mechanism for sulphonation of benzene. Is this reaction is reversible or irreversible? Support your answer with suitable diagram.<br>(ii) Determine the concentration of $Cd^{2+}$ ions in the following electrochemical cell,<br><br>$$Fe, Fe^{2+}(0.1M) \| Cd^{2+}(x), Cd$$<br><br>Given that EMF of the cell E = + 0.02 V and $E^0$ = 0.04 V<br><br>(iii) What are plastic hazards? Give few examples. Discuss how biodegradable polymer is useful for the prevention of health hazards. | **[20]** | **CO2, CO3 & CO5** |