GULBARGA UNIVERSITY, KALABURAGI

Bachelors of Science (B.Sc.)

Chemistry Syllabus
(With Effect from 2023-24)

SEMESTER VI

DISCIPLINE SPECIFIC COURSE (DSC)
and
SKILL ENHANCEMENT COURSE (SEC)

(AS PER NEP – 2020)

B.Sc. Semester – VI

Discipline Specific Course (DSC)-13

Course Title: Physical Chemistry (Theory) : III

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-13	**Theory**	**04**	**04**	**60 hrs.**	**2hrs.**	**40**	**60**	**100**

Course Outcomes (COs):At the end of the course students will be able to:

1: Explain the ionization of electrolyte, migration and transport number of ions and its determinations. Enable to explain the conductivity of ions, variation with dilution, differentiating specific, equivalent and molar conductivity. Describe the application of conductivity measurement for concentration, dissociation of weak electrolyte.

2: Explain the degree of dissociation for strong and weak electrolytes and their conductivity with concentrated and dilute solution.

3: Aware about the importance of energy sources, alternative energy from various sources. Explain about the working principle and applications of different batteries and fuel cells.

4: Distinguish between reversible and irreversible cells. Concept of EMF and its measurement.

5: Describing the electrode potential, types, applications for pH and EMF determinations.

6 : Explain the spectral distribution of block body radiation, Plank's radiation law, Photoelectric effect, Compton effect.

7: Describing Schrödinger's wave equation, wave functions, Eigen function and Eigen values, normalization and orthogonality

8 : Interpretation of equations of motion, elementary wave motion and operators.

09: Derive expression of Solutions of Schrödinger equations of a free particle, particle in a box.

10: Explain the dimensions, degeneracy, reflection and penetration of a particle in a one dimensional box of semi-infinite barrier, a particle in a box of finite walls.

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DISCIPLINE SPECIFIC COURSE : SEMESTER - VI

DSC-13: Physical Chemistry-III: **Theory-60 hours**

Unit-I: **15 hours**

Electrochemistry-II: (6 hours)

Definition of EMF of a cell, standard electrode potential, IUPAC sign convention; Types of reversible electrodes with examples: gas-metal ion, metal-ion, metal insoluble salt-anion electrode, Redox electrode with examples – Quinhydrone electrode (To be mentioned).

Reference electrodes – Construction and working of SHE and calomel electrode. Concentration cell – Derivation of EMF using Nernst equation for electrolytic concentration cell without transference. Liquid junction potentials, elimination of liquid junction potential. Potentiometric titration involving only redox systems ($K_2Cr_2O_7$vs. FAS).

Quantum Mechanics: (9 hours)

Physical interpretation of the wave function. Operators: Laplacian, Hamiltonian, Linear and Hermitian operators. Angular Momentum operators and their properties. Commutation of operators. Postulates of quantum mechanics, Schrödinger wave equation based on the postulates of quantum mechanics and its importance. Concepts of solutions of Schrödinge rwave equation for a Particle in a one dimensional box, particle in a three-dimensional box. Quantum mechanical degeneracy, tunneling (no derivation). Application of Schrödinger equation to harmonic oscillator, rigid rotator. Eigen functions and eigen values of angular momentum. Ladder operator method for angular momentum. Schrödinger equation to hydrogen atom in spherical polar co-ordinates. Total wave functions of hydrogen atom. Quantum numbers and their characteristics. List of wave functions for few initial states of hydrogen like atoms.

UNIT-II: **15 hours**

Chemical Dynamics-I

Macroscopic and microscopic kinetics, Review of theories of reaction rate-Collision theory and Transition state theory, Comparison of collision theory with transition state theory, Arrhenious equation-characteristics, Significance of energy of activation, Temperature coefficient and its evaluation. Thermodynamical formulation of reaction rates (Wyne-jones and Eyring treatment), Reaction between ions in solutions – Influence of ionic strength on reaction rates (primary and secondary salt effects).

Concept of Steady state kinetics, Chain reactions - chain length and chain inhibition, comparison ofphotochemical and thermal reactions, Mechanisms of thermal and photochemical reactions between hydrogen-bromine and hydrogen-chlorine. Comparative study of thermal and photochemical hydrogen-halogen reactions. Pyrolysis of acetaldehyde, Decomposition of ethane.

Kinetics of fast reactions- Introduction, Study of reactions by relaxation method (Temperature andpressure jump), flow method (Plug flow method and Stopped flow method), Flash photolysis and Shock tube method.

UNIT-III: **15 hours**

Chemical Dynamics-II

Kinetics of homogeneous catalysis-kinetics of auto catalytic reactions, kinetics of acid-base catalysed reactions. Comparison of enzyme catalysed and chemical catalysed reactions, Mechanism (Lock and Key theory), Kinetics of enzyme catalyzed reactions - Henri-Michaelis- Menten mechanism, Significance of Michaelis-Menten constant, Lineweaver-Burk plot. Effects of enzyme concentration, pH, Temperature, Activators and Inhibitors on enzyme activity.

Theories of unimoleuclar reactions: Perrin theory and Hinshelwood theory.

Surface chemistry- Adsorption: Effect of temperature on adsorption, Mechanism of adsorption, Derivation of BET equation, Estimation of surface area using BET equation, Gibbs adsorption isotherm and its

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significance, Surface tension and surface energy, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Surface film on liquids (electro-kinetic phenomena), Catalytic activity of surfaces.

UNIT-IV: **15 hours**

Thermodynamics: Nernst heat theorem; statement and concept of residual entropy, evaluation of absolute entropy, Third law of thermodynamics. Entropy of vapourisation and Trauton's rule, limitations of Van't Hoff's equation. Fugacity - its variation and determination, activity and activity coefficient. Partial molar quantities; Concept of chemical potential, variation of chemical potential with temperature and pressure, derivation of Gibbs-Duhem equation, Duhem-Margules equation and its application.

Phase Rule: Derivation of phase rule from the concept of chemical potential. Application of Phase Rule to three components system: Principle of triangular diagram: Plots for a mixture of three liquids consisting of one, two and three pairs of partially miscible liquids.

Statistical Thermodynamics: Energy states: macro and microstates, Limitation of classical thermodynamics, Distinguish between classical mechanics and statistical mechanics. Sterling approximation, derivation of Maxwell–Boltzmann statistics, statistical interpretation of entropy, application of statistics to gases-monoatomic ideal gas (No derivations). Partition functions and thermodynamic parameters, expressions for translational, rotational, vibrational and electronic partition functions, enthalpy, energy, Gibbs free energy.

Partition functions: Definition and significance, molar and molecular partition functions, Derivation of expression of partition function for rotational, vibrational, electronic, and translational motion. Sackur Tetrode Equation, Relation between equilibrium constant and partition function.

References:

1. Physical Chemistry, P.W. Atkins, Juliode Paula, ELBS, 7th edition, (2002).
2. Physical Chemistry: A Molecular Approach, McQuarie and Simon, Viva, New Delhi, (2001).
3. Introduction to Quantum Chemistry, A.K. Chandra,Tata McGraw Hill, (1988).
4. Quantum Chemistry, Ira. N. Levine, Prentice Hall, New Jersey, (1991).
5. Quantum Chemistry, R.K. Prasad, New Age International, 2nd edition, (2000).
6. Quantum Chemistry through problems and solutions, R.K. Prasad, New Age International (1997).
7. Chemical Kinetics- K.J. Laidler, McGraw Hill. Inc. New York (1988).
8. Principles of Chemical Kinetics – House J.E. Wm C Brown Publisher, Boston, (1997).
9. Kinetics and Mechanism - A.A. Frost and R.G. Pearson, John-Wiley, New York, (1961).
10. Chemical Kinetic Methods - C. Kalidas, New Age International Publisher, New Delhi (1995)
11. S.H. Maran and C.F. Pruton, 4th Edn., Oxford, and IBH publishing Co. Pvt. Ltd. New Delhi (1965).
12. Principles of Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing House.
13. Essential of Physical Chemistry; Arun Bahl, B.S. Bahi and G.D. Tuli, S. Chand and Co.
14. Physical chemistry; R. L. Madan, G. D. Tuli, S. Chand and Co.
15. Elements of Physical Chemistry - Glasstone and Lewis - Macmillan.
16. Text book of Physical Chemistry - S. Glasstone- Macmillan (India) Ltd.
17. Numerical Problems on Physical Chemistry- Gashal, Books and Allied (P) Ltd.,
18. Physical Chemistry, P. C. Rakshit, V Edition (1988), Fourth Reprint (1997), Sarat Book House, Calcutta.
19. W. Kauzmann, Kinetic Theory of Gases (Thermal Properties of Matter, Vol I), Benjamin, Reading, MA, 1966.

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Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Quiz/ Assignment/ Small Project	10
Seminar	10
Total	**40 Marks**
Formative Assessment as per guidelines.	

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B.Sc. Semester – VI

Discipline Specific Course (DSC)-14

Course Title: Physical Chemistry Practicals

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-14	**Practical**	02	04	60 hrs.	3hrs.	25	25	50

Course Outcomes (COs):At the end of the course students will be able to:

1: Understand to apply the knowledge of conductivity, emf and absorbance to performing the experiments.

2: Acquire skills for handling analytical instruments like potentiometer, conducto meter, pH meter & colorimeter.

DSC-14: Physical Chemistry Practicals:

PART-A:

1. Conductometric titration of weak acid versus weak base.
2. Conductometric titration of solution of strong acid (HCl) and salt ($CuSO_4$) versus Strong Base.
3. Potentiometric titration of FAS versus $K_2Cr_2O_7$.
4. Potentiometric titration of FAS versus $KMnO_4$.
5. Potentiometric method of determination of dissociation constant of H_3PO_4.
6. Potentiometric titration of weak acid against a strong base using quinhydrone electrode and calculation of pK_a and K_a of the weak acid.
7. Determination of the acidic and basic dissociation constant and isoelectric point of an amino acid by *p*H-metry.

PART-B:

1. Determination of rate constant of hydrolysis of ester in presence of two different concentrations of catalyst (HCl).
2. Determination of rate constant of hydrolysis of ester catalyzed by HCl at different temperatures.
3. Determination of rate constant of decomposition of Hydrogen peroxide catalyzed by $FeCl_3$.
4. Determination of degree of hydrolysis of aniline hydrochloride at room temperature and calculation of dissociation constant of the base by *p*H-metry.
5. Analysis of a binary mixture of two miscible liquids and to determine the composition of the given unknown mixture by Abbe's refractometry.
6. Determination of *p*H of acetic acid with sodium acetate buffer by *p*H-metry method.
7. Colorimetric estimation of Fe^{2+} ions using 1,10-phenothralene.

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Note: *The list of experiments is suggestive. However, faculties / academic bodies may add more experiments / references or incorporate suitable revisions based on infrastructure facilities available at the Institution.*

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B.Sc. Semester – VI

Discipline Specific Course (DSC)-15

Course Title: SPECTROSCOPY (Theory)

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-15	**Theory**	**04**	**04**	**60 hrs.**	**2hrs.**	**40**	**60**	**100**

Course Outcomes (COs):At the end of the course, students will be able to:

1: To understand the basic concepts of Spectroscopy techniques.

2 : Define spectroscopy and different regions of electromagnetic spectrum.Basics of UV/visible spectroscopy. Different kind of transitions that can take place within molecule

3: Explain the origin of IR spectrum.Describe different types of vibrational modes of simple molecules.Explain the principles of different types of IR instruments. Outline different applications of UV, IR.

4: Understand basic principles of PMR, molecular structure signals, interpretation of PMR structure of simple organic molecules, principle, instrumentation, definitions of parent peak and base peak.

5: Application of Spectroscopy techniques for different applications

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DSC-15 : SPECTROSCOPY :

Theory - 60 hours

Unit-I: **15 hours**

Symmetry and Group Theory in Chemistry: (7 hours)

Definition of groups, sub-groups, cyclic groups, conjugate relationships, classes, simple theorems in group theory. Symmetry elements and symmetry operations, point groups, Schöenflies notations, representations of groups by matrices, reducible and irreducible representations, characters of representations, Great Orthogonality Theorem (without proof) and its applications, group multiplication tables for C_{2v} (Example : water) C_{3v} (Example : ammonia), character tables for C_n (consider C_2 and H_2O_2 as an example for C_2 point group), C_{nv} (consider C_{2v} and water as an example for C_{2v} point group), D_{nh} (consider D_{3h} and BF_3 as an example for D_{3h} point group) point groups to be worked out.

Molecular spectroscopy : (8 hours)

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Raman spectroscopy: Theory, Qualitative treatment of Rotational Raman effect; Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion. Relation with IR spectroscopy, Instrumentation.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies. Fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, PQR branches.

Unit-II: **15 hours**

Organic Spectroscopy:

General principles, Introduction to absorption and emission spectroscopy.

UV Spectroscopy: Types of electronic transitions, λ_{max},Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λ_{max} for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; Range, finger print region, and its significance; frequency and energy of IR radiations, interaction of IR radiation with organic molecules, molecular vibrations- stretching and bending vibrations, Hook's law, Stretching frequency of functional groups in benzaldehyde, acetophenone, ethyl acetate, aniline and methyl amine. Infrared spectra of simple molecules, C=C stretching and –C=H bending vibrations in vinyl ethers. Calculation of vibrational frequencies using Hooke's law derived for the motion of a spring. Sample handling in IR spectra of both gases and liquids.

Unit-III: **15 hours**

Nuclear Magnetic Resonance spectroscopy:

Nuclear magnetic resonance (NMR) spectroscopy: Absorption of electromagnetic radiation, proton NMR (^1H NMR) , Magnetic properties of nuclei, population of energy levels, the Larmor precession, relaxation processes, chemical shift, the relationship between number of signals and their ratio, shielding mechanism, spin-spin interactions, rules governing the interpretation of first order spectra, effect of chemical exchange on spectra. NMR spectra: Downfield and up field position of a signal and integral curve. ^1H NMR spectrum of organic molecules like ethanol, p-xylene. Factors influencing chemical shift, anisotropic effect.

Mass Spectrometry: Basic principles- Theory of mass spectrometry, instrumentation, mass spectrum, the molecular ion peak, determination of molecular formula, Mc-Lafferty rearrangement. Metastable ion peaks and their importance. Nitrogen rule. General transformation modes. Homolytic cleavage heterolytic cleavage. Retro-Deil's Alder reactions. Important features of mass spectra of hydrocarbons - alkanes, alkenes and cycloalkenes, alcohols, phenols, aldehydes, ketones, carboxylic acids.

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Unit-IV: **15 hours**

Atomic spectroscopy: Atomic absorption, atomic emission and atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

Electron Paramagnetic Resonance (EPR) Spectroscopy: Basic principles, selection rules, intensity, width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin-orbit coupling, zero field splitting and Kramer's degeneracy, rules for interpreting spectra, factors affecting the magnitude of values. Instrumentation, applications to the study of free radicals, coordination compounds, biological studies and rate of electron exchange reactions.

Nuclear Quadrupole Resonance (NQR) Spectroscopy: Quadrupole nuclei, quadrapole movement, electric field gradient, the NQR experiment, structural information from NQRspectra.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Quiz/ Assignment/ Small Project	10
Seminar	10
Total	**40 Marks**
Formative Assessment as per guidelines.	

References:

1. Chemical Applications of Group Theory, F. A. CoZon, Wiley Eastern (1976).
2. Molecular Symmetry, D. S. Schonl and, Van Nostr and (1965).
3. Introduction to Molecular Spectroscopy, C. N. Banwell, TMH EdiBon (1994).
4. Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw Hill (Int. Students Edition) (1988).
5. Molecular Spectroscopy, J. D. Graybeal, McGraw Hill (Int. Students EdiBon) (1990).
6. Spectroscopy, Vols. 1-3, B. P. Straughan and W. Walker, Chapman Hall (1976).
7. Physical Methods in Chemistry – R.S. Drago, Saundercollege.
8. Structural Methods in Inorganic Chemistry – E.A. Ebsworth, D. W.H. Ranbin and S.Cradock, ELBS.
9. Spectra of Inorganic and Coordination Compounds - K. Nakamoto.
10. Infrared Spectroscopy - C.N.R. Rao.
11. Introduction to Spectroscopy - D.L. Pavia, G.M. Lampman and G.S. Kriz, Thomson Learning, Singapore (2001).
12. Spectroscopic Identification of organic compounds - R.M. Silverstein and F.X. Webster, 6th Edition, John Wiley and Sons, India Ltd. (2006).
13. Interpretation of Mass Spectroscopy – Mc Lafferty.
14. Organic Spectroscopy, William Kemp.

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B.Sc. Semester – VI

Discipline Specific Course (DSC)-16

Course Title: **Analytical and Organic Chemistry Practicals**

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-16	**Practical**	**02**	**04**	**60 hrs.**	**3hrs.**	**25**	**25**	**50**

Course Outcomes (COs):At the end of the course, students will be able to:

1: Understand the types, theory, technique and applications of separation techniques l i k e solvent extraction and chromatography, dyes and colors used in day-to-day life.

2 : To understand to apply the knowledge of analytical Techniques for performing the

Experiments

DSC-16 : Analytical and Organic Chemistry Practicals:-

Part-A: Separation techniques and pharmaceutical analysis

1. Separation of amino acids by paper chromatography and measuring Rf values.
2. Separation of $Co^{2+}$and Ni^{2+} by paper chromatography and measuring Rf values.
3. Separation of Ni(II) and Fe(II) by complexation with DMG, extraction of Ni(II)-DMG complex in chloroform and determination of its concentration by colorimetry.
4. Separation of amino acids from organic acids by ion exchange chromatography,
5. Separation of Mg (II) and Fe (II) by ion exchange chromatogrphy.
6. Determination of aspirin present in tablets conductometrically / titrimetrically
7. Determination of amino acids colorimetrically using ninhydrin.
8. Determination of Glucose / Sucrose colorimetrically using Fehling's Solution.
9. Preparation of magnesium bisilicate (Antacid).

Part-B: Industrial Chemistry

PART-B : Organic Estimations (Quantitative analysis):

1. Titrimetric estimation of aminoacids.
2. Determination of saponification value of oil.
3. Estimation of glucose by Fehling's method.
4. Estimation of phenol.
5. Estimation of aniline.
6. Iodine value of oil by chloramine-T method.
7. Analysis of food adulterants in Tea Powder, Coffee Powder, turmeric powder, Chili Powder, oil/fat, milk, etc.
8. IR peak analysis for functional groups using recoded IR Spectra.

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Note: *The list of experiments is suggestive. However, faculties / academic bodies may add more experiments / references or incorporate suitable revisions based on infrastructure facilities available at the Institution.*

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B.Sc. Semester – VI

INTERNSHIP

Course Title: Chemistry Internship

Type of Course	Theory / Practical	Credits	Instruction hour/ week	Total No. of Lectures/Hours / Semester	Durationof Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
INTERNSHIP	**Practical**	**02**	**04 hrs**	**90 hrs**	**-**	**50**	**0**	**50**

Internship:

A course requiring students to participate in a professional activity or work experience, or cooperative education activity with an entity external to the education institution, normally under the supervision of an expert of the given external entity. A key aspect of the internship is induction into actual work situations for 2 credits. Internships involve working with local industry or private organizations, business organizations, artists, crafts persons, and similar entities to provide opportunities for students to actively engage in on-site experiential learning.

Note;

1. 1 credit internship is equal to 30hrs on field experience.
2. Internship shall be Discipline Specific of 45-60 hours (2 credits) with duration 1-2 weeks.
3. Internship may be full-time/part-time (full-time during last 1-2 weeks before closure of the semester or weekly 4 hrs in the academic session for 13-14 weeks). College shall decide the suitable method for programme wise but not subject wise.
4. Internship mentor/supervisor shall avail work allotment during 6th semester for a maximum of 20 hours.
5. The student should submit the final internship report (45-60 hours of Internship) to the mentor for completion of the internship.
6. Method of evaluation: Presentations/Report submission/Activity etc.

Wherever internship is not feasible, the students can to choose project work

Project Work: Plant training in industries/short term work in the department/other:

The project work may include in educational institutions/R&D organizations/data mining/review of current literature/theoretical methods/ computer applications.

Experimental work may involve studies on synthesis/measurements/study of properties/ characterization by physical methods/ activities for reported/unreported research or any suitable combination thereof. In case of the students who would work outside the campus, the supervising staff member may visit.

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Question paper pattern for FIFTH and SIXTH Semesters

Paper Title and Code:

[Time: 2 hrs] [Max. Marks: 60]

Instructions to candidates:

1. **The question paper contains Three sections A, B, and C. Answer all Sections.**
2. **Write equations and neat diagrants wherever necessary.**
3. **Equal weightage shall be given to each unit.**

SECTION – A

Answer any FIVE of the Following questions. **(5 x 2 = 10)**

1. a)
   b)
   c)
   d)
   e)
   f)
   g)
   h)

SECTION – B

Answer any FOUR of the Following questions. **(4 x 5 = 20)**

2. a)

   b)

3. a)

   b)

4. a) One question form each unit

   b)

5. a)

   b)

6. a)

   b) Questions from unit I and II

7. a)

   b) Questions from unit III and IV (3 + 2 or 2+3)

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SECTION – C

Answer any THREE of the Following questions. **(3 x 10 = 30)**

8 a)

b)

9 a)

b)

10 a) One Full Question from Each Unit (5 + 5 or 6 + 4 or 4 + 6)

b)

11 a)

b)

12 a)

i)

ii) Questions from unit I and II (3 + 2 or 2 + 3)

b)

i)

ii) Questions from unit III and IV (3 + 2 or 2 + 3)

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