GONDWANA UNIVERSITY, GADCHIROLI

B.Sc.-I Semester I (Chemistry)

(Effective from 2012-13)

1) There will be two theory papers in chemistry in every semester which carry 50 marks each and duration of paper is 3 hrs.
2) There will be internal assessment of 20 marks per semester.
3) There will be practical examination of 4-5 hours duration and carries 30 marks.

So, the total marks allotted to the chemistry subject per semester is 150 marks.

Theory (100 marks) + Internal assessment (10+10 marks) + Practical (30 Marks) = 150 marks (total)

4) Student should have to pass in theory, practical & Internal Assessment separately (Minimum passing percentage in every case is 35%)
5) The internal assessment will be based on Attendance, Home assignment, Unit test, Terminal test and participation in departmental activities.

The following syllabi are prescribed on the basis of six lectures per week and six practical periods per batch per week. Each theory paper consists of four units of twelve lectures per unit.

THEORY PAPER PATTERN FOR VARIOUS SEMESTER

Semester No.	Paper –I	Paper-II
1S	Inorganic Chemistry	Organic Chemistry
2S	Organic Chemistry	Physical Chemistry
3S	Inorganic Chemistry	Physical Chemistry
4S	Inorganic Chemistry	Organic Chemistry
5S	Organic Chemistry	Physical Chemistry
6S	Inorganic Chemistry	Physical Chemistry

Marking pattern

Que.-1 (From Unit 1) – (A-5 Marks + B-5 Marks)= 10 Marks or
(a-2 ½ + b-2 ½ + c-2 ½ + d-2 ½)= 10 Marks

Que.-2 (From Unit 2) – (A-5 Marks + B-5 Marks)= 10 Marks or
(a-2 ½ + b-2 ½ + c-2 ½ + d-2 ½)= 10 Marks

Que.-3 (From Unit3) – (A-5 Marks + B-5 Marks)= 10 Marks or
(a-2 ½ + b-2 ½ + c-2 ½ + d-2 ½)= 10 Marks

Que.-4 (From Unit4) – (A-5 Marks + B-5 Marks)= 10 Marks or

(a-2 ½ + b-2 ½ + c-2 ½ + d-2 ½)= 10 Marks

Que.-5 Solve any 10 out of 12 short answer question each carry one mark

(3 short question from each unit)

B.Sc. Part I (Semester - I)

Paper – I (Inorganic Chemistry)

Total marks : 50 Total Lectures : 48

Note : Figures to the right hand side indicate number of lectures

Unit I

(A) Atomic Structure : Idea of de-Broglie matter waves, Heisenberg's uncertainty principle, Schrodinger wave equation, significance of Ψ and Ψ^2, quantum numbers, radial and angular wave functions and probability distribution curves, atomic orbitabls, shapes of s, p and d-orbitals, Aufbau and Pauli's exclusion principle, Hund's multiplicity rule, electronic configuration of the elements and ions.

[6 L]

(B) Periodic Properties : Atomic and ionic radii, ionization energy, electron affinity and electronegativity - definition, trends in periodic table and applications in predicting and explaining the chemical behavior, factors affecting ionization potential. Pauling's and Mulliken's scales of electronegativity, effective nuclear charge and Slater's rules with some exercise.

[**6 L]**

Unit II

(A) Covalent Bond : Valance bond theory and its limitations, directional characteristics of covalent bond, overlap criteria of bond strength, Bond energy, bond strength, bond order and bond angle. Various types of hybridization and shapes of simple inorganic molecules and ions. Valance shell electron pair repulsion (VSEPR) theory to NH_3 H_3O^+, SF_4 ClF_3 ICl^-_4 and H_2O.

[**6 L]**

(B) Molecular Orbital Theory : LCAO approximation, wave equation for molecular orbitals, difference between bonding and antibonding MOs in terms of energy and electron density distribution curves, order of energy levels in MOs. MO diagrams for homonuclear diatomic molecules of hydrogen, helium and second row of periodic table. Concept of non-bonding MOs in HF molecule, Coulson's MO diagram of CO and NO.

[**6 L]**

Unit III

(A) s – Block Elements : Comparative study of s – block elements with respect to: i) Atomic & ionic radii, ii) Ionisation Energy iii) Electron Affinity iv) Electronegativity v) Reducing property. Diagonal relationship between Li & Mg, Salient features of hydrides, Salvation and Complexation tendencies including their functions in biosystems.

[6 L]

(B) p-Block Elements : Comparative study of p – block elements with respect to: i) Atomic & ionic radii, ii) Ionisation Energy iii) Electron Affinity iv) Electronegativity v) Oxidation State. Diagonal relationship between Be & Al, Preparation, properties and structure of hydrides of 5^{th} group elements. Nature and bonding in phosphorous trioxides (P_2O_3), phosphorous pentaoxide (P_2O_5) and oxyacids of phosphorous.

[6 L]

Unit IV

(A)**Hydrides of boron:** Structure and bonding in diborane and borazine, Classification and applications of carbides. **[6 L]**

(B)Basic properties of Iodine, interhalogen compounds : Preparation and structure of ClF, ClF_3, IF_5 & IF_7. Polyhalides : Classification and structure of I_3^-, I_5^-, I_7^- and ICl_4^-.

[2 L]

(C)**Chemistry of noble gases :** Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon fluorides and oxyflurides. **[4 L]**

B.Sc. Part I (Semester - I)

Paper – II (Organic Chemistry)

Total marks : 50 Total Lectures : 48

Note : Figures to the right hand side indicate number of lectures

Unit I

Structure And Bonding In Organic Molecules, Reactive Intermediates, Mechanism Of Organic Reactions.

(A) Definition and unique Properties of organic compounds and their classification. Covalent bond, Hybridization in organic molecules (sp, sp^2, sp^3), bond length, bond angles, bond energies. **[3 L]**

(B) Types of Reagents and Reactive Intermediates : Homolytic and Heterolytic fission, Electrophiles and Nuculeophiles Carbocations, Carbanions and free radicals, their generation stability and reactions. **[4 L]**

(C) Electronic Displacements : Inductive effect, Electromeric effect, Resonance and Hyperconjugation (definition, examples and applications of these effects) **[3 L]**

(D) Types of Reactions : (In brief with suitable example of each)

a) Addition, b) Elimination c) Substitution d) Rearrangement reactions **[2 L]**

Unit II

Stereochemistry Of Organic Compounds :-

A) Concept of isomerism, Type (Structural chain, position, functional group and stereo isomerism) Representation of organic. Molecules zig–Zag structures, projection formulae (Saw horse - Andiron), Newman, Fisher and Dotted – wedge **[2 L]**

B) Optical isomers – Isomer number and tetrahedral carbon atom, chirality, optical isomerism with one and two asymmetric carbon atoms (Tartaric acid), Polarimeter. Specific rotation. Enantiomerism R & S Nomenclature **[3 L]**

C) Racemisation, resolution and its methods, inversion and retention of configuration, Asymmetric synthesis [2 L]

D) Geometrical isomerism – Defination condition for geometrical isomerism, cis-trans and E-Z nomenclature, physical and chemical properties of geometrical isomerism of maleic and fumaric acid and 1-butene. [3 L]

E) Conformation isomerism in alkanes, free rotation about carbon carbon single bond, conformation of ethane, butane, relative stability of different conformation

[2 L]

Unit - III

Alkane, Cyloalkane, Alkene And Diene :-

A) Alkane : Nomenclature laboratory methods of preparation by Wurtz reaction, Kolbes reaction and decarboxylation of carboxylic acid, Industrial methods of preparations. Physical properties, reactions of alkanes. Combustion, cracking, LPG, Octane Numbers, Free radical mechanism of halogenations of methane. **[3L]**

(B) Cyclolkanes : Nomenclature, Method of formation (3-6 member rings), a) Freund's method, b) Dickmann's method. Chemical reactions of cycloalkanes : Oxidation, Aromatization and Chlorination. Baeyer's strain theory, theory of strainless rings.

[3 L]

C) Alkene : Nomenclature, preparations, dehydration of alcohols and dehydro halgenation of alkyl halide. Physical properties Reactions of alkenes, hydroboration, oxidation, epoxidation, ozonolysis hydration, hydroxylation, Polymerization of alkenes (ethylene and propylene) Ionic and Free radical mechanism of addition reaction of alkenes, Markownikoffs rule and peroxide effect

[4L]

(C) Diene : Nomenclature and classification, Method of formation and Chemical reactions 1-2 and 1-4 additions and Diels-Alder reaction of Conjugated dienes. [2L]

Unit - IV

Aromatic Hydrocarbons And Aromaticity

A) Nomenclature, Isomerism of Aromatic Compounds **[1 L]**

B) Structure and Orbital diagram of benzene, Aromaticity and Huckel's rule. **[3 L]**

C) Mechanism of Electrophilic Aromatic Substitution : Nitration, Nuclear and Side Chain Halogenations, Birch Reduction. Friedal Craft Alkylation and Acylation **[4L]**

D) Orientation : Effect of substituent groups. Activating and deactivating groups. Directing influence of following groups in the light of modern electronic theory

(-OH, -Cl, -NO_2, -COOH and –CH_3 groups) **[4L]**

Semester - I

Chemistry Practical

Total Laboratory Session : 30 **Total Marks : 30**

Inorganic Chemistry – **12 Laboratory Sessions**

Semi micro qualitative analysis of inorganic salt mixture containing two acidic radicals of different group and two basic radicals of same groups. At least six mixtures to be given, Analysis of basic radicals to be done by using spot test reagents.

Following radicals to be given

Carbonate, Nitrite, Sulphite, Sulphide, Sulphate, Chloride, bromide, iodide nitrate, silver (1), Mercury (II), lead (II) copper (II), bismuth (III), mercury (I) , cadmium (II), tin (II) arsenic (III), antimony (III), iron (III), chromium (III), aluminium (III), nickel (II), cobalt (II) manganese (II) zinc (II), calcium (II) strontium (II), barium (II), magnesium (II)

Organic Chemistry Practical : **12 Laboratory Sessions**

A) Determination of boiling point of following compounds – Ethanol and benzene. Mixed melting point determination Urea – Cinnamic acid mixture of various compostitions (1:4, 1:1, 4:1). Simple distillation of ethanol – water mixture using water condenser

B) Qualitative Analysis of simple Organic Compound

Detection of extra elements (N, S, and halogen), Functional group detection (Phenolic -OH, Carboxylic acid –COOH. Aldehyde – CHO, Keto , Carbohydrates, Amine, Amides, Nitro and Anilide)

Distribution of Marks for Practical Examination

Time 4-5 hours (One Day Examination) Marks 30

Inorganic Chemistry (Exercise) ……..……. 12

Organic Chemistry (Exercise)

(Element : 4 M, Functional group: 4 M. & M.Pt./ B. Pt. 4 M)…… 12

Viva-Voce ……..…. 03

Record ……..…. 03

Total : 30 marks

B.Sc. Part – I (Semester - II)

Paper – I (Organic Chemistry)

(Effective from session 2012-13)

The examination in Chemistry of second semester shall comprise of two theory papers internal assessment and practical examination. Theory papers will be of 3 hrs. duration and carry 50 marks each. The Internal assessment will carry 20 marks. The practical examination will be of 4 - 5 hours duration and carry 30 marks.

The following syllabus is prescribed on the basis of twelve lectures per unit and 6 practical periods per batch per week. Each theory paper has been divided into 4 units. There shall be one question in every unit with internal choice for each 10 marks and fifth one compulsory question covering all the syllabus of four units.

B.Sc. Part – I (Semester - II)

Paper – I (Organic Chemistry)

Total Lectures : 48, Total Marks : 50

Note : Figures to the right hand side indicate number of lectures.

Unit- I

Halogen Derivates

A) **Alkyl Halides** : Synthesis of ethyl bromide from ethane and ethylene. Reactions of ethyl bromide (submission and elimination). Mechanism of SN^1, SN^2 and E_1, E_2 reactions. Elimination verses substitution. [**4L]**

B) Alkenyl Halides : Synthesis and reactions of vinyl, allyl and benzyl chlorides. Comparison of reactivity of vinyl and allyl chloride. [**4L]**

C) Aryl Halides : Synthesis and reactions of Chlorobenzenes. Mechanism of Nucleophilic (benzene) substitution reaction comparison of reactivity of chlorobenzene and benzyl chloride. [**4L]**

Unit II

Alcohols, Phenols and Ethers :

A) Alcohols : Synthesis and reactions of ethyl alcohol. Ethylene glycol and Glycerol. Mechanism of Pinacol – Pinacolone rearrangement. [**5L]**

B) Phenols : Classification and nomenclature of phenols. Methods of formations a) from Cumene, b) from benzene, Acidic character. Comparative acidic strength of alcohols and phenols. Reaction of Phenols. Electrophilic aromatic substitution.

a) Acetylation b) Carboxylation (Kolb's reaction.) c) Fries rearrangement (with mechanism) d) Claisen Rearrangement e) Gatterman Synthesis f) Hauben-Hoesch reaction g) Reimer – Tiemann reaction. [**5L]**

(C)Ethers: Introduction, synthesis and reactions of diethyl ether. Relative relativities of alcohols and ethers. [**2L]**

Unit III

Aldehyde and Ketone

A) Nomenclature, Structure and reactivity of the carbonyl group. [**1L]**

B) Synthesis of aliphatic aldehyde and ketone by oxidation and dehydrogenation of alcohols, from carboxylic acid, acid chloride. Grignard reagent and from alkene.

[2L]

Synthesis of aromatic aldehyde (Benzaldehyde) by Resenmund reduction Gatterman Koach reaction Reimer – Tiemann reaction and from nitrils and ketone (Benzophenone) by Friedel Craft's acylation or benzoylation. [**3L]**

C) Physical properties and Chemical reactions such as nucleophilic addition reaction, oxidation and reduction and some miscellaneous reactions like Aldol condensation and cross Aldol condensation. Cannizzaro's reaction, Benzoin, Perkin, Knovenagel condensations and their mechanism. Condensation with ammonia and its derivatives. Wolff-Kishner reduction, Wittig and Mannich reactions. [**6L]**

Unit IV

Polymer Chemistry

A) Principles of Polymer Chemistry. Industrial Practices and application. Classification of Polymers. General Methods of polymerization: Addition (chain growth) and Condensation (step growth) polymerization, Mechanism of Additional Polymerization. Addition free radical, cationic and anionic polymerization, Copolymerization – Block and Graft Copolymers.

[**3L]**

B) Natural rubber, Vulcanization of rubber, Synthetic rubbers – Neoprene SBR, Buna N rubber.

[3L]

C) Molecular mass of polymers. Biodegradable polymers – polyhydroxy butyrate (PHB), Polylactic acid (PLA). **[2L]**

D) Some commercially important polymers – a) addition polymers – Polyethene, polypropene, polystyrene, b) condensation polymers – Polyester, Polyamide, Phenol- formaldehyde and melamine formaldehyde resin. [**4L]**

B.Sc. Part - I (Semester – II)

Paper – II (Physical Chemistry)

Unit – I

(A) Mathematical Concepts : Logarithmic relations, curve sketching, Linear graphs calculation of slopes, differentiation of functions like kx ex, xn sin x log x etc. maxima and minima, partial differentiation, Integration of useful / relevant functions. Permutations and combinations (introductory), Factorials, Concept of units with references to C.G.S. and S.I. units Inter conversion of units. [**6L]**

(B) Nuclear Chemistry : composition of Nucleus, Mass defects, nuclear binding energy, Average binding energy per nucleon, explanation of nuclear stability on the basis of graph between average binding energy per nucleon and atomic mass number, Nuclear reactions : Fission and Fusion. Nuclear models : Liquid drop model, Shell model and comparison between them. Explanation of fission by liquid drop model. Applications of radioisotopes. [**6L]**

Unit – II

Gaseous State

(A) Postulates of kinetic theory of gases, derivation of kinetic gas equation, deduction of various gas laws from kinetic gas equation, Qualitative discussion of the Maxwell – Boltzmann distribution of molecular velocities. Effect of temperature on molecular velocities. Different types of molecular velocities (Most probable RMS and average) and expressions for them. Their inter relationships. Mean free path collision diameter and collision number.

[6L]

(B) Ideal gas and real gases, behavior of real gases, deviations from ideal behaviors, explanation of the terms – Compressibility factors and Boyle temperature. Causes of deviation from ideal behaviors. Van der Waal's equation of state, explanation of state, explanation of behavior of

real gases. Critical phenomenon (P-V isotherms of real gases). Continuity of states. The isotherms of Vander Waal's equation, Relationship between critical constants and Van der Waal's constants Reduce equation of state law of corresponding state.

[6L]

Unit III

Liquid State

(A) Intermolecular forces, structure of liquids (a qualitative description), structural differences between solids, liquids and gases, liquid crystals, difference between liquid crystals, solid and liquid. Classification, structure of Nematic and Cholestric phases, Thermographic and seven segment cell. [**6L]**

(B) Properties of Liquid i) Surface tension : Explanation, methods of determination, Capillary rise method and drop number method, Parachor value and its application ii) Viscosity, Explanations, coefficient of viscosity, Effect of temperature on Viscosity, relative viscosity, specific and intrinsic viscosity. Method of determination by Ostwald viscometer.

(iii) Refractive index : specific refraction, molar refraction and chemical constitution Method of determination by Abbe's Refractometer. [**6L]**

Unit - IV

Chemical Kinetics

(A) Concept of reaction rate, factors affecting the rate of a reaction – concentration temperature, pressure, solvent light, catalyst. Mathematical characteristics of zero, first and second order reactions. Pseudo order reactions. Half life and mean life of reaction with examples. Determination of order of reaction – method of integration, differential method, method of half life period and isolation method. Experimental methods based on conductometry, polarimetry etc. Effect of temperature on rate of reaction, Arrhenius equation concepts of activation energy.

[**6L]**

(B) Collision theory of bimolecular reactions (hard sphere model). Transition state theory Expression for rate constant based on equilibrium constant and thermodynamic aspects.

[**3L]**

(C) Catalysis : Characteristics of **catalysed** reactions, classification of catalysis with examples (Homogeneous, Gas phase, liquid phase catalysis, Heterogeneous catalytic reaction, enzyme catalysis, Autocatalysis etc.) [**3L]**

Semester II

Chemistry Practical

Total Laboratories Sessions 30 **Total Marks : 30**

Organic Chemistry Practical's – 12 Laboratory Sessions

A) Purification of an impure organic compound by crystallization / Sublimation method and determination of melting point of purified sample (Five compounds (1) Phthalic acid, 2) Acetanilide, 3) Benzoic acid, 4) Phenylthiourea 5) Naphthalene.

Note: i) Students should report the melting point of sample before and after crystallization / Sublimation.

ii) Solvents like water, water + alcohol, Alcohol can be selected for crystallization.

B) Organic Preparations (Any Five)

1. Preparation of acetanilide (Acetylation of Aniline)
2. Preparation of Benzanilide (Benzoylation of Aniline)
3. Preparation of Iodoform from ethanol or Acetone.
4. Preparation of m-di-Nitrobenzene (Nitration)
5. Preparation of tri-Bromoaniline from Aniline (Bromination)
6. Preparation of Benzoic acid from Benzamide (Hydrolysis)
7. Preparation of Benzoic acid from Benzaldehyde (oxidation)
8. Preparation of Semicarbazone from Acetone.

Note :

a) Student should perform the single stage preparation with the help of given procedure.

b) Melting point and percentage yield should be reported.

c) The sample should be submitted.

d) Students should recrystalize the sample with suitable solvent.

e) Student should know the reaction and its mechanism of given single stage preparation.

f) Organic Chemistry.

Physical Chemistry Practical: 12 Laboratory Sessions

Expt. 1. To determine relative coefficient of viscocity of the given liquid by Ostwald viscometer.

Expt. 2. To determine percentage composition (v/v) of the given mixture of ethyl alcohol and water by viscocity measurement.

Expt. 3 To determine surface tension of liquid by stalagmometer.

Expt. 4 To determine parachor value of $-CH_2$ group by stalagmometer.

Expt. 5. To compare cleaning power of detergents by stalagmometer.

Expt. 6. To determine refractive index of the given liquid by Abb's refractometer.

Expt. 7 To determine the specific reaction rate of the hydrolysis of methyl acetate catalyzed by H^+ ions at room temperature.

Expt. 8 To determine specific reaction rate of hydrolysis of ethyl acetate catalyzed by base at room temperature (Saponification).

Distribution of Marks for Practical Examination :

Time 4-5 hours (One Day Examination) Marks 30

Organic Preparation (Exercise)	……. 12
Physical Chemistry (Exercise)	……. 12
Viva- Voce	……. 03
Record	……. 03

	Total : 30

Reference Books Recommended (Common for Semster – I and Semester – II)

1. Principles of Inorganic Chemistry by Puri. Sharma and Kalia – *S. Naginchand & Co. Delhi.*
2. Text book of Inorganic Chemistry by A. K. De. *Wiley East Ltd.*
3. Selected Topies in Inorganic Chemistry by Malik, Tuli and Madan – *S. Chand and Co.*
4. Modern Inorganic Chemistry by R. C. Agrawal, *Kitab Mahal.*
5. Instrumental Methods of analysis by Chatwal and Anand, *Himalaya Publishing House.*
6. Concise Inorganic Chemistry by J. D. Lee, *ELBS.*
7. Inorganic Chemistry by J. E. Hoheey – *Harper and Row.*
8. Fundamental concepts of Inorganic Chemistry by E. S. Gilreath, *McGraw Hill book Co.*
9. Modern Inorganic Chemistry by W. L. Jolly, *McGraw Hill Int.*
10. Chemistry Facts, Patterns and Principles by Kneen, Rogers and Simpson, *ELBS.*

11. Theoretical Principles of Inorganic Chemistry by G.S. Manku, *Tata McGraw Hill.*

12. Inorganic complex compounds by Murmann, Chapman and Hall.

13. Text book of Inorganic Chemistry by K. N. Upadhayaya, *Vikas Publishing House, Delhi.*

14. Advanced Practical Inorganic Chemistry by Gurdeep Raj. *Goel Publishing House, Meerut.*

15. Co-Ordination Chemistry by D. Banerjee, *TMH Publication.*

16. Text book of Inorgnaic Chemistry by Marathe, Bhadange, Mopari and Kubade.

17. Organic Chemistry by R. T. Morrison and R. T. Boyd, 6^{th} edition, *PHI.*

18. Organic Chemistry by Pine, 5^{th} edition.

19. Inorganic Chemistry Vol. I, II and III by Mukharjee, Singh and Kapoor – *Willey Eastern.*

20. Organic Chemistry by S. K. Ghosh.

21. Reaction Mechanism in Organic Chemistry by S.M. Mukharjee and S.P. Singh.

22. Spectroscopy of Organic Compounds by P. S. Kalsi.

23. Stereochemistry and Mechanism through solved problems by P.S. Kalsi.

24. Organic Chemistry by TWG Solomons, 4^{th} edition, *John Wiley.*

25. Hand book of Organic Analysis by H. J. Clarke, Arnold Heinmen.

26. Text book of Practical Organic Chemistry by A. I. Vogel.

27. Text book of Organic Chemistry by Jamode, Ganar, Makode, Waghmare, Mahaja, Toshinwal.

28. Text book of Organic Chemistry by P.S. Kalsi published by *Macmillian India Ltd. 1999, Delhi.*

29. Comparative Practical Organic Chemistry (Qualitative Analysis) by V. K. Ahluwalia and Sunita Dhingra, Orient Longman.

30. Comprehensiv Practical Organic Chemistry (Preparation and Qualitative Analysis) by V. K. Ahluwalia and Renu Agrawal. Orient Longman.

31. Physical Chemistry : Walter J. Moore, 5^{th} edn. New Delhi.

32. Physical Chemistry : G. M. Barrrow, *McGraw Hill, Indian Edn.*

33. Principle of Physical Chemistry : Maron and Prutton.

34. Principles of Physcial Chemistry : Puri and Sharma

35. Physical Chemistry : P. W. Atkins, 4^{th} Edn.

36. Text book of Physical Chemistry : P. L. Sony O. R. Dhrma.

37. Physcal Chemistry : Levine
38. Practical Physical Chemistry : Palit and De.
39. Practical Physical Chemistry : Yadao
40. Practical Physical Chemical : Khosla.
41. Laboratory Mannual of Physical Chemistry : W. J. Popiel
42. Chemistry for Degree Student, Dr. R.L. Madan, *S.Chand and Co. New Delhi.*
43. F.Y. B.Sc. Inorganic Chemistry : Semester-I by Dr. S.B. Rewatkar, Dr. E.L.Ramteke, Y.P. Thawari & S.M.Sontakke – *Shell Publication, Nagpur.*
44. F.Y. B.Sc. Organic Chemistry : Semester-I by Y.P.Thawari, Dr. S.B. Rewatkar, S.M.Sontakke, Dr. E.L.Ramteke,– *Shell Publication, Nagpur.*
45. F.Y. B.Sc. Organic Chemistry : Semester-II by Y.P.Thawari, S.M.Sontakke, Dr. S.B. Rewatkar, T.D. Kose,– *Shell Publication, Nagpur.*
46. F.Y. B.Sc. Physical Chemistry : Semester-II by T.D.Kose, Dr. S.B. Rewatkar, S.M.Sontakke, Y.P.Thawari, – *Shell Publication, Nagpur.*
47. F.Y. B.Sc. Practical Chemistry : Semester-I by Dr.S.B. Rewatkar, Dr. E.L.Ramteke, Dr. K.R. Lanjewar, Y.P.Thawari, – *Shell Publication, Nagpur.*
48. F.Y. B.Sc. Practical Chemistry : Semester-II by Dr.S.B. Rewatkar, Dr. E.L.Ramteke, Dr. K.R. Lanjewar, Y.P.Thawari, – *Shell Publication, Nagpur. (Proposed)*
49. Inorganic Chemistry B. Sc. Part I, Sem-I by Dr. N.E. Kathale, S. V. Madhamshettiwar, Dr. D. B. Patil.
50. Physical Chemistry B. Sc. Part I, Sem-II by Dr. N.E. Kathale, S. V. Madhamshettiwar, Dr. D. B. Patil.