

INSTITUTE OF CHEMICAL TECHNOLOGY
(Deemed to be University under section 3 of the UGC Act 1956)

PHARMACEUTICAL SCIENCES AND TECHNOLOGY

Syllabus Structure for the B.Tech Pharma First year

Semester I

No.	Subjects	Hours/week (L + T)	Marks	Credits
CHT 1121	Inorganic Chemistry	2+1	50	3
CHT 1131	Organic Chemistry-I	3+1	100	4
MAT 1101	Applied Mathematics-I	2+2	100	4
PYT 1101	Applied Physics-I	3+1	100	4
	TOTAL	15	350	15
GEP 1101	Engineering Graphics-I	8	100	4
PYP 1102	Physics Laboratory	4	50	2
CHP 1122	Inorganic Chemistry Laboratory	4	50	2
CHP 1132	Organic Chemistry Laboratory	4	50	2
	Total Practicals	20	250	10
		35	600	25

Semester II

No.	Subjects	Hours/week (L + T)	Marks	Credits
CHT 1231	Organic Chemistry-II	3+1	100	4
CHT 1211	Analytical Chemistry	2+1	50	3
CET 1501	Material & Energy Balance Calculations	2+2	100	4
MAT 1102	Applied Mathematics-II	2+2	100	4
PYT 1103	Applied Physics-II	2+1	50	3
	TOTAL	18	400	18
MAP 1201	Engineering Applications of Computers	4	50	2
CHP 1232	Organic Chemistry Laboratory	4	50	2
CHP 1222	Analytical Chemistry Laboratory	4	50	2
HUP 1101	Communication Skills	4	50	2
	Total Practicals	16	200	8
		34	600	26

Syllabus Structure for the B.Tech Pharma Second year

Semester III

Course code	Subjects	Hours/week (L + T)	Marks	Credits
GET1104	Engineering Mechanics and Strength of Materials	2+1	50	3
GET1105	Electrical and Electronics Engineering*	2+1	50	3
CHT1341	Physical Chemistry	3+1	100	4
PHT1021	Spl 1: -General Aspects of Pharmaceuticals and Physiopharmacology - I	3+1	100	4
BST1101	Spl 2: General Microbiology	2+1	50	3
BST1103	Spl 3: Biochemistry	2 +1	50	3
	TOTAL	20	400	20
GEP1106	Electrical and Electronics Engineering Laboratory	4	50	2
CHP1342	Physical Chemistry Laboratory	4	50	2
PHP1021	Pr1: -Physiopharmacology Laboratory	4	50	2
	Total Practicals	12	150	6
		32	550	26

Semester IV

Course code	Subjects	Hours/week (L + T)	Marks	Credits
CET1105	Transport Phenomena	3+1	100	4
PHT1041	Spl 4: - Medicinal Chemistry-I	3+1	100	4
PHT1051	Spl 5: -Chemistry of Natural Products	3+1	100	4
PHT1022	Spl 6: -Physiopharmacology - II	2+1	50	3
PHT1052	Spl 7: -Medicinal Natural Products	2+1	50	3
	TOTAL	18	400	18
PHP1052	Pr 2: -Medicinal Natural Products Laboratory	4	50	2
PHP1071	Pr 3: Biochemistry Laboratory	4	50	2
PHP1072	Pr 4: Microbiology Laboratory	4	50	2
	Total Practicals	12	150	6
		30	550	24

Syllabus Structure for the B.Tech Pharma Third year

Semester V

No.	Subjects	Hours/week (L + T)	Marks	Credits
GET1104	Chemical Engineering Operations	2+1	50	3
GET1104	Chemical Reaction Engineering	2+1	50	3
PHT1042	Spl 8 -Pharmaceutical Chemistry	2+1	50	3
PHT1061	Spl 9: -Pharmaceutical Biotechnology	2+1	50	3
PHT1031	Spl 10: -Pharmaceutical Analysis	2+1	50	3
PHT1011	Spl 11: -Technology of Liquids and Topicals	2+1	50	3
	TOTAL	18	300	18
PHP1011	Pr 5: -Technology of Liquid and Topicals	8	100	4
PHP1031	Pr 6: -Pharmaceutical Analysis	4	50	2
PHP1061	Pr 7: -Biotechnology Laboratory	4	50	2
	Total Practicals	16	200	8
		34	500	26

Semester VI

No.	Subjects	Hours/week (L + T)	Marks	Credits
CHT1341	Instrumentation	2+1	50	3
PHT1043	Spl 12: -Medicinal Chemistry-II	3+1	100	4
PHT1044	Spl 13: -Drug Discovery Process and Drug Design	2+1	50	3
PHT1012	Spl 14: -Technology of Solid Dosage Forms	2+1	50	3
PHT1045	Spl 15: -Catalysis and Catalytic Processes	2+1	50	3
PHT1062	Elective-I : Recombinant DNA Technology	2+1	50	3
	TOTAL	19	350	19
CHP1342	Chemical Engineering Laboratory	4	50	2
PHP1042	Pr 8: -Pharmaceutical Chemistry Laboratory	8	100	4
PHP1012	Pr 9: -Solid Dosage Forms Laboratory	4	50	2
	Total	16	200	8
		35	550	27

Syllabus Structure for the B.Tech Pharma Final year

In-Plant Training: 50 marks/2 credits

Semester VII

No.	Subjects	Hours/week (L + T)	Marks	Credits
1	Project Economics	2+1	50	3
2	Industrial Psychology and Human Resource Management	2+1	50	3
PHT1046	Spl 16: -Process Technology Drug and Intermediats	2+1	50	3
PHT1013	Spl 17: -Validation and Regulatory Requirements	2+1	50	3
PHT1014	Spl 18: -Technology of Sterile Products	2+1	50	3
PHT1047	Elective II:– Structural Analysis by Spectroscopy	2+1	50	3
	TOTAL	18	300	18
PHP1046	Pr 10: -Process Technology Laboratory	8	100	4
PHP1014	Pr 11: -Sterile Products Laboratory	4	50	2
PHP1071	Seminar	4	50	2
	Total Practicals	16	200	8
		34	500	26

Semester VIII

No.	Subjects	Hours/week (L + T)	Marks	Credits
1	Industrial Management	2+1	50	3
2	Value Education	2+1	50	3
3	Design and Analysis of Experiments	2+1	50	3
PHT1015	Spl 19: -Drug Delivery Systems	2+1	50	3
PHT1016	Spl 20: -Nanoscience and Technology	2 +1	50	3
PHT1017	Elective III:– Pharmaceutical Packaging Technology	2+1	50	3
	TOTAL	18	300	18
PHP1016	Green Chemistry Laboratory	4	50	2
PHP1072	Experimental Project	12	150	6
	Total	16	200	8
		34	500	26

**Total credits of all semesters = 25 (Sem I) + 26 (Sem II) + 26(Sem III) + 24 (Sem IV)
+ 26 (Sem V) + 27 (Sem VI) + 2 (IPT) + 26 (Sem VII) + 26 (Sem VIII) = 208**

**Total Marks: 600 (Sem I) + 600 (Sem II) + 550 (Sem III) + 550 (Sem IV) + 500 (Sem V)
+ 550 (Sem VI) + 50 (IPT) + 500 (Sem VII) + 500 (Sem VIII) = 4400**

Detailed Syllabus for First Year B. Tech (Pharma)

Semester I

Sr. No.	Topic	Hrs
1.	CHT 1121 – Inorganic Chemistry (50 marks) 3hr./week	
	Periodic Table, s,p,d and f elements and their general properties, correlations among various properties.	3
	Main group Chemistry: Hydrogen, Chemistry of Group IA, II B and Group IIIB to VIIB elements and noble gases.	12
	Chemical Bonding: Valence Bond theory and Molecular orbital theory	3
	Coordination Chemistry: Nomenclature, Werner theory, VSEPR, crystal field theory, electronic and magnetic properties of the complexes.	12
	Organometallics: Metal Ligand concept, , types of ligands, Effective atomic number rule reactions using organometallic compounds like addition, insertion, migration. Concepts of sigma bond and pi bond formation. Application of organometallic complexes in hydrogenation, hydroformylation, carbonylation etc.	15
	Reference Books <ul style="list-style-type: none"> • Concise Inorganic Chemistry, J.D. Lee, Wiley India Edition • Basic Inorganic Chemistry, F.A. Cotton and G. Wilkinson, John Wiley and Sons 	
2.	CHT 1131 – Organic Chemistry I (100 marks) 4hr./week	
	Nomenclature of organic compounds	5
	Mechanisms of organic reactions: Types of Organic Reaction, Reactive intermediates; their generation, structure, stability and general reactions.	10
	Stereochemistry: Elements of symmetry, stereochemistry of compounds containing one and two carbon atoms. Racemates and their resolution, conformation of cyclic and acyclic systems, E and Z isomers of olefins, Idea of asymmetric synthesis.	10
	Chemistry of alkanes, cycloalkanes, alkenes and alkynes: Alkanes from petroleum, methods of synthesis. Properties, General reactions, oligomerization and polymerization of olefins, acidity of terminal alkynes, alkenes as fuels.	10
	Aromaticity and Aromatic hydrocarbons: Huckel's theory of Aromaticity and monocyclic carbocyclic aromatic species, BTX, Aromatic hydrocarbons. Fridel-Craft alkylation. General reaction of aromatic hydrocarbons.	10
	Aliphatic and aromatic halides: Methods of preparation, properties, General reactions, SN ¹ ,SN ² reactions, Aromatic nucleophilic reactions.	15

	Reference Books: <ul style="list-style-type: none"> Organic Chemistry, J. McMurry, Brooks/Cole Organic Chemistry, T.W.G. Solomons, C.B. Fryhle, John Wiley and Sons Inc., Organic Chemistry, L.G. Wade Jr, Pearson Education StereoChemistry of Carbon compounds, E.L. Eliel, Mcgraw-Hill Organic Chemistry, Paula Y. Bruice, Pearson Education 	
3.	MAT 1101 Applied Mathematics I (100 marks) 4hr./week	
	Rank of matrices, Solutions of system of linear equations (Gauss-elimination, LU-decomposition etc.) Eigenvalues and Eigenvectors, Caley-Hamilton theorem:	6
	Numerical methods for solution of linear and non-linear single and multiple algebraic equations. Solution of transcendental Equations, Newton's method, Fixed point iterative method etc.	6
	Interpolation and extrapolation: interpolating polynomials for equal and non-equal spaced data (Forward, backward, central and spline) their applications to numerical integration (trapezoidal rule, Simpson's Rule, Romberg Integration etc.) and numerical differentiations.	10
	Probability of Statistics: Review of elementary probability theory, Random variables, Functions of random variables, probability distribution functions, expectation, moments and moment generating functions, Joint probability distributions, binomial, Poisson, and Normal distribution.	12
	Sampling distributions, Point and interval estimations, Statistical hypothesis tests, t-tests for one and two samples, F-test, χ^2 -test, tests of hypothesis for proportion, Simple Applications;	10
	Statistical Methods for Data Fitting: Linear, multi-linear, non-linear regression, ANOVA	6
	Differential Calculus : Review and Concepts, Higher order differentiation and Leibnitz Rule for the derivative, Rolle's and Mean Value theorems, Taylor's and Maclaurin's theorems, Maxima/Minima, convexity of functions, Asymptotes, Radius of curvature;	10
	Reference Books: <ul style="list-style-type: none"> Advanced Engineering Mathematics, Erwin Kreyszig, John-Wiely. Advanced Engineering Mathematics S. R. K. Iyengar, R. K. Jain, Narosa. Introductory Methods Of Numerical Analysis, S. S. Sastry, PHI. A First Course in Probability, Sheldon Ross, Pearson Prentice Hall. 	

	<ul style="list-style-type: none"> Probability and Statistics in Engineering , W.W. Hines, D. C. Montgomery, D.M. Goldsman, John-Wiely 	
4.	PYT 1101 – Applied Physics-I: (100 marks) 4hr./week	
	Thermal Physics Temperature and the zeroeth law of thermodynamics, heat conduction, first law of thermodynamics, kinetic theory of gases, Maxwell-Boltzmann distribution, some aspects of non-ideal behavior, entropy and second law of thermodynamics	12
	Optics Introduction, Diffraction – basic concepts, diffraction at a straight edge, diffraction at single and multiple slits, Resolving power – Rayleigh’s criterion, resolving power of various optical components.	6
	Solid State Physics Crystal Structure Crystal structure of solids, unit cell, space lattices and Bravais lattices, Miller indices, directions and crystallographic planes. Cubic crystals – SCC, BCC, FCC, Hexagonal crystals – HCP, atomic radius, packing fraction, ion-ligancy and critical ratio, Bragg’s law, determination of crystal structure using Bragg spectrometer	6
	Semiconductors Formation of energy bands in solids, concept of Fermi level, classification of solids – conductor, semiconductor and insulator. Intrinsic semiconductor, Effect of doping – extrinsic semiconductors.	4
	Ultrasonics Generation of ultrasound – mechanical, electromechanical transducers, propagation of ultrasound, attenuation, velocity of ultrasound and parameters affecting it, measurement of velocity, cavitation, applications of ultrasound.	8
	Optical Fibers Introduction, optical fiber as a dielectric waveguide – total internal reflection, numerical aperture and various fiber parameters, losses associated with optical fibres, step index and graded index fibers, applications of optical fibers.	6
	Lasers and Microwaves Introduction to interaction of radiation with matter, principles and working of a Laser– population inversion, pumping, various modes, threshold population inversion, types of Lasers – solid state, semiconductor, gas, applications of Lasers. Microwaves – production and applications.	6

	<p>Reference Books:</p> <ul style="list-style-type: none"> • Physics: Vols. I and II – D. Halliday and R. Resnick, 2nd ed, 1962, Wiley Eastern. • Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, 1963, Narosa. • Concepts of Modern Physics – A. Beiser, 1969, McGraw-Hill. • Introduction to Modern Optics – G. R. Fowles, 2nd ed, 1975, Dover Publications. • A Course of Experiments with LASERs – R. S. Sirohi, 2nd ed, 1991, Wiley Eastern. • Optical Fibre Communication – G. Keiser, 3rd ed, 2000, McGraw-Hill. • Optoelectronics – J. Wilson and J. F. B. Hawkes, 2nd ed, 1992, Prentice-Hall India. • Ultrasonics: Methods and Applications – J. Blitz, 1971, Butterworth. • Applied Sonochemistry – T. J. Mason and J. P. Lorimer, 2002, Wiley VCH. • Solid State Physics – A. J. Dekker, 1957, MacMillan India. 	
5.	GEP 1101 – Engineering Graphics – I (100 marks) 4hr./week	
	Solid geometry projections of solids like prism, pyramids, cylinders and cones. Sections of solids. Developments of solids. Interpenetration of simple solids including cone and cylinder. Isometric scales and projections.	
	Machine drawing-Orthographic projections, First Angle and Third Angle method of projections. Conventions in dimensioning and in sections. Forms and proportions of screw threads, bolts, nuts, locking devices for nuts, studs, set-screws, hangers and brackets. Free hand sketches of the above parts	
6.	PYP 1102 – Physics Laboratory (50 marks) 3hr./week	
	Students will perform eight to ten experiments from selected topics in modern physics, heat and fluid mechanics	
7.	CHP 1122 – Inorganic Chemistry Laboratory (50 marks) 3hr./week	
	Volumetric Analysis: Preparation and Standardisation of Volumetric solutions. Acid base reactions, titrations of a mixture of (a) hydrochloric and acetic acid (b)Sulfuric and phosphoric acid (c) carbonate and bicarbonate. Oxidation - reduction titrations involving permanganate, dichromate, ceric sulfate, iodine (tri-iodide) potassium bromate. Precipitation titration: Mohrs and Volhards titrations.	

	Compleximetric titrations involving EDTA: Determination of hardness of water. Determination of Manganese in pyrolusite. Gravimetric analysis: Gravimetric determination of Fe, Ni, SO_4^{2-} and Cl. Analysis of a Fe-Ni alloy. Suitable number of experiments from the above list will be performed.	
8.	CHP 1132 – Organic Chemistry Laboratory I (50 marks) 3hr./week	
	Identification of an organic compound through elemental analysis, group detection, physical constants (m.p and b.p) and derivatisation.	
	Estimation of selected organic compounds like: aniline/phenol, formaldehyde/acetone, glucose, glycerol. Neutral equivalents of acids and bases, SAP value of an oil.	

Semester II

Sr. No.	Topic	Hrs.
1.	CHT 1231 – Organic Chemistry – II (100 marks) 4hr./week	
	Chemistry of Hydroxy derivatives of aliphatic and aromatic compounds: Methods of preparation, Properties, General reaction, Acidity of phenol	10
	Aldehydes and ketones: Methods of preparation. Fridel-Craft acylations and related reactions, properties and reactivity, general reactions	16
	Carboxylic acids and their Derivatives: Carboxylic acids, esters, amides, acid chlorides and anhydrides Methods of preparation, Properties, Acidity of carboxylic acids, General reaction of their compounds. Interconversion.	10
	Amines: Methods of preparation of primary, secondary and tertiary amines, properties, Basicities and general reactions.	7
	Ethers, epoxides and sulphur acids: Methods of preparation, General reaction, Acidity of sulphur acids. EO condensates.	5
	Heterocyclic chemistry: Comparison with carbocyclic compounds, methods of Preparation, Regenerated compounds Pyrrole, Furan, Thiophene, Pyridine, Quinoline and Isoquinoline. Retrosynthetic approach, characteristic properties and Reactions	12
	Reference Books: <ul style="list-style-type: none"> • Organic Chemistry, J. McMurry, Brooks/Cole • Organic Chemistry, T.W.G. Solomons, C.B. Fryhle, John Wiley and Sons Inc. • Organic Chemistry, L.G. Wade Jr, Pearson Education • Organic Chemistry, Paula Y. Bruice, Pearson Education 	
2.	CHT 1211 – Analytical Chemistry (50 marks) 3hr./week	
	Concept of quality: Definition of quality, quality control and assurance, TQM. Correlation between quality and analysis, steps and types of analysis, Stoichiometry and expression of concentration.	2
	Theory of errors: Sources and classification of errors. Statistical treatment of analytical data and presentation of results	2
	Sampling of solids, liquids and gases.	2
	Evaluation and validation of analytical methods	2
	Good laboratory practices.	1
	Fundamentals of chromatography, Chromatography methods: GLC, HPLC, TLC, HPTLC, ion chromatography, hyphenated techniques like GC-MS, LC-MS	6
	Fundamentals of absorption / emission spectroscopy: Absorption of light, UV – VIS spectrophotometry, Beer-Lambert Law, characteristic bond frequencies. Energy levels in atoms and	10

	molecules. Principles of Atomic Absorption Spectroscopy (AAS), its application, feature of the instrument. Principles of IR spectroscopy, application, and features of the instrument	
	Diamagnetism and paramagnetism, nuclear spin, NMR spectroscopy, chemical shift, nuclear spin - spin coupling, EPR spectroscopy, Spectroscopy based on Scattering.	6
	Fundamentals of Imaging Techniques: SEM TEM	4
	Electrochemical instruments, techniques and applications, controlled current and controlled potential principles, amplifiers, potentiostats, galvanostats, cyclic voltametry, chronoamperometry, chronopotentiometry, applications such as corrosion, electroplating, anodising, organic and inorganic electrosynthesis, fuel cells.	8
	Thermal Methods : TGA, DTA, DSC	4
	References: <ul style="list-style-type: none"> • Instrumental methods of Chemical Analysis, E.W. Ewing, McGraw Hill. • Instrumental Methods of Analysis, H.H. Willard, L.L. Merrit, J.A. Dean and F.A. Shette, Jr, CBS Publishers and Distributors, New Delhi. • New Instrumental Methods in Electrochemistry, P.D. Delaha • Instrumental methods of analysis, D.A. Scoog and D.M. Wes • Inorganic quantitative analysis, A.I. Vogel, Longmans ELBS. 	
3.	CET 1501 Material and Energy Balance Computations (100 marks) 4hr./week	
	Introduction to Chemical Engineering: Historical evolution of Chemical Engineering and Chemical Process Industries, Chemistry to Chemical Engineering	4
	Revision of Units and Dimensions., Mathematical techniques, Introduction to use of calculators.	4
	Mole concept, composition relationship and stoichiometry	2
	Applications of Laws of Conservation of Mass and Energy to single and Multistage processes.	6
	Behaviour of gases and vapors	4
	Material balances for reacting systems.	8
	Introduction to psychrometry humidity and air-conditioning calculations.	6
	Calculation of X-Y diagrams based on Raoult's law.	4
	Fuels and combustion	6
	Unsteady state material balances.	4
	Material and energy balances for complete plants.	8
	Material and energy balances using computers.	4
	Reference Books: <ul style="list-style-type: none"> • Chemical Process Principles, Hougen O.A., Watson K. M. 	

	<ul style="list-style-type: none"> • Basic Principles and Calculations in Chemical Engineering, Himmelblau • Stoichiometry, Bhatt B.I. and Vora S.M. 	
4.	MAT 1102 Applied Mathematics II (100 marks) 4hr./week	
	Functions of two or more variables, Limit and continuity, Partial differentiation, Total derivatives, Taylor's theorem for multivariable functions and its application to error calculations, Maxima/Minima, Jacobian.	10
	Integral Calculus : Improper integrals, Beta and Gamma functions, Differentiation under the integral sign, Curve tracing, Application to length, Area, volumes, Surface of revolution, Moment of inertia, Centre of gravity	14
	Differential Equations: Solution of Higher order ODE with constant and variable coefficients and its applications to boundary and initial value problems, Series solution of differential equations, Bessel functions, Legendre Polynomials, Error function, Solution by orthogonal set of functions.	12
	Fourier Series and Fourier integrals, Fourier and Laplace Transforms and their applications to differential equation (both ODEs and PDEs)	14
	Numerical methods for solution of ODEs (initial values and boundary values) using single step methods (RK, Euler's explicit and implicit methods). Multi-Step methods (predictor – corrector methods etc), Solution of Stiff ODEs, Adaptive step size, Shooting method , Solutions of Differential Algebraic Equations	10
	Reference Books: <ul style="list-style-type: none"> • Advanced Engineering Mathematics, Erwin Kreyszig, John-Wiely • Advanced Engineering Mathematics S. R. K. Iyengar, R. K. Jain, Narosa. • Elements of <i>Applied Mathematics</i>. Volume 1, P.N.Wartikar and J.N.Wartikar, Pune Vidyarthi Graha. • Introductory Methods Of Numerical Analysis, S. S. Sastry, PHI. • Numerical Solution of differential Equations, M. K. Jain, Wiley Eastern. 	
5.	PYT 1103 – Applied Physics – II (50 marks) 3hr./week	
	Quantum Mechanics Introduction to quantum physics, blackbody radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, verification of matter	12

	waves, uncertainty principle, Schrodinger wave equation, Born's interpretation of the wave function, particle in a box, quantum harmonic oscillator, hydrogen atom (no detailed derivation)	
	Rheology Introduction to rheology Basic concepts in fluid flow, importance of non-linearity, concepts of elasticity in solids and liquids, Hooke's law, Newton's law, scaling of time by means of Deborah number for characterisation of flow behaviour in melts and liquids, constitutive equations relating stress and deformation variables.	6
	Melt Viscosity Concept of viscosity, variation of viscosity with different experimental conditions as shear rate, time of shearing, temperature and pressure, shear dependent viscosity, definition of Newtonian behaviour and Non-Newtonian behaviour, concepts of shear thinning and shear thickening.	6
	Viscoelasticity Introduction to viscoelasticity, Maxwell and Kelvin models, relaxation models, relaxation spectrum, creep and creep recovery, complex modulus and complex viscosity	6
	Reference Books: <ul style="list-style-type: none"> • Perspectives of Modern Physics – A. Beiser, 1969, McGraw-Hill. • Introduction to Rheology – H. A. Barnes, J. F. Hutton and K. Walters, 4th ed, 1996, Elsevier Science. • Physical Chemistry of Polymers – A. Tager, 2nd ed, 1978, Mir Publishers. • Viscoelastic Properties of Polymers – J. D. Ferry, 3rd ed, 1980, Wiley. 	
6.	MAP 1201 Engineering Applications of Computers (Lab)	
	Computer Programming Languages: FORTRAN, C, C++, etc.	32
	Softwares : Wordprocessing, Spreadsheets, Database, etc.	8
	Softwares for Libraries etc.	8
	Introduction to Computer Hardware, Architecture, Networking	12
7.	CHP 1232 – Organic Chemistry Laboratory II (50 marks) 3hr./week	
	Synthesis of several organic compounds such as acetanilide, m-dinitrobenzene, methyl salicylate, benzamide, o-chlorobenzoic acid, tribromophenol, p-nitrobenzoic acid, azo dye, etc. to demonstrate the various unit processes like oxidation, reduction, alkylation chlorination, nitration, etc. Separation and purification of binary mixtures of the type : water soluble-water insoluble, both water	

	soluble, liquid-liquid by distillation, dissociation –extraction ,crystallization, etc.	
8.	CHP 1222 – Analytical Chemistry Laboratory (50 marks) 3hr./week	
	Students will perform eight to ten experiments based on topics that are covered in the theory	
9.	HUP 1101 Communication Skills. (50 marks) 3hr./week	
	Development of communication skills in oral as well as writing. The writing skills should emphasize technical report writing, scientific paper writing, letter drafting, etc. The oral communication skills should emphasize presentation skills. Use of audio-visual facilities like power point, LCD for making effective oral presentation. Group Discussions	

Detailed Syllabus for Second Year B. Tech (Pharma)

Semester III

Sr. No.	Topic	Hrs
1.	GET1104 – Engineering Mechanics and Strength of Materials (50 marks) 3hr./week	
2.	GET1105 – Electrical and Electronics Engineering (50 marks) 3hr./week	
3.	CHT1341- Physical Chemistry (100 marks) 4hr./week	
4.	PHT1021–General Aspects of Pharmaceuticals and Physiopharmacology - I (100 marks) 4hr./week	
	Over view of Pharmaceutical Industry	1
	Introduction to human body, Organization of human body, Different system of human body, Definitions and examples of different drug categories, composition and functions of blood, cardiac cycle	14
	Introduction to pharmacopoeias, Routes of drug administration, introduction to bio pharmaceuticals	10
	Discussion of monographs and general test procedures and their importance, inorganic chemicals of pharmaceutical importance with respect to their manufactures and uses, assay methods	5
	Hematinics, thrombolytics, coagulants / anticogulants	4
	Digestive system antacids, purgatives	4
	Structure and function of kidney, diurectics	4
	Respiratory system	3
	General pharmacology (ADME, routes of administration, MOA)	10
	Bioassay: histamine and antihistaminic, Pharmacology and local anesthetics	5
	<ul style="list-style-type: none"> • Remington’s Pharmaceutical Sciences, A.R.Gennaro Mac Pub. Co. Easton, Pennsylvania 1990 • Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia. • Bentely’s Textbook of Pharmaceutics, Rawlins, Cassell Ltd, London • “Anatomy Physiology”, C.C. Calcuttal Medical Allied agency, 1994 • “Anatomy Physiology”, Toutora, 10th Johns Wiley and Sons, 	

	NY, 2003 <ul style="list-style-type: none"> • “Pharmacology” Tripath, 4th Jaypee Brother New Delhi, 1999 • “Pharmacology” Satoskar-Bhandarkar, Popular Prakshan, Mumbai, 2003 • “Pharmacology” Seth, Churchill Livingstone, New Delhi, 1998 • “Handbook of in Pharmacology”, S. K. Kulkarni, Vallabh Prakashan, New Delhi, 1999 • “Element of in Pharmacology”, Dr. R. K. Goyal, 10th S. B. Shah, Ahmadabad, 2003 	
5.	BST1101 – General Microbiology (50 marks) 3hr./week	
6.	BST1103 – Biochemistry (50 marks) 3hr./week	
7.	GEP1106–Electrical and Electronics Engineering Laboratory (50 marks) 4hr./week	
8.	CHP1342–Physical Chemistry Laboratory (50 marks) 4hr./week	
9.	PHP1021–Physiopharmacology Laboratory (50 marks) 4hr./week	
	RBC count, WBC count, Differential leucocytes count, Hemoglobin estimation, Blood grouping	
	Histology, study of effects of various drugs on isolated frogs heart e.g Ach, adrenaline, effect of adrenergic and cholinergic blockers, effect of ions on the isolated frog heart (through audiovisual demonstration)	
	Demonstration of different routes of administration of drugs. Effects of clotting time, bleeding time	

Semester IV

Sr. No.	Topic	Hrs.
1.	CET1105-Transport Phenomena (100 marks) 4hr./week	
2.	PHT1041 – Medicinal Chemistry-I (100 marks) 4hr./week	
	Introduction to Medicinal and Pharmaceutical Chemistry	1
	(a) Methods of classification of drugs based on structure and biological activity	1
	(b) Concept of acidity and basicity of drugs and pKa values. Introduction of absorption distribution of drugs based on physicochemical properties	3
	(c) Drug metabolism chemistry	3
	Study of the chemistry of the following classes of drugs: nomenclature, classification, SAR, Synthesis Anti-infective agents: antiseptic and disinfectant; antibacterial- sulfonamides, quinoline, DHFR antagonists, antibiotics including stability and degradation products, antiparasitic agents- antimalarial, antiamoebic, antihelminthic, antimycobacterial agents, antifungal agents, anticancer agents, antiviral agents	18
	Study of the chemistry of the following classes of drugs including nomenclature, classification, SAR, Synthesis:	
	(a) ANS drugs: Drugs affecting neurotransmission- cholinergic, adrenergics	8
	(b) CNS drugs: Serotonergics and their antagonists	6
	(c) CNS drugs General Anesthetics, hypnotics, anti-seizure drugs, Antipsychotic and antianxiety agents, analgesics, anti-Parkinson drugs,	20
	<ul style="list-style-type: none"> • Burger's Medicinal Chemistry & Drug Discovery: Vol. 1 to 6; Ed.: A. Burger and M. E. Wolff; John Wiley & Sons-New Jersey. • Foye's Principles of Medicinal Chemistry; Ed.: W. O. Foye; Lippincott Williams & Wilkins-Philadelphia. • Textbook of Medicinal and Pharmaceutical Chemistry; Ed.: Charles Owens Wilson; Lippincott Williams & Wilkins – Philadelphia. • Organic Synthesis-The Disconnection Approach; Ed.: Warren S.; John Wiley & Sons-Chichester. 	

	<ul style="list-style-type: none"> Pharmaceutical Substances: Synthesis, Patents, Applications (N-Z); Ed: A. Kleemann; Georg Thieme Verlag-Stuttgart. Strategies for Organic Drug Synthesis and Design; Ed.: Lednicer & Daniel; John Willey & Sons Inc., New York. Organic Chemistry of Drug Synthesis: Vol. 1 to 6; Ed.: Daniel Lednicer; John Wiley & Sons Inc.- New York. 	
3.	PHT1051-Chemistry of Natural Products (100 marks) 4hr./week	
	Vitamins: Classification, chemistry of biological role, synthesis	16
	Hormones (other than steroid):Classification, chemistry of biological role, synthesis, Bioactive peptides including peptide hormones: Chemistry of peptide, characterization, protection of amino acids, Synthesis of peptides general, synthesis of peptide hormones, Structure of poisonous peptides.	16
	Terpenes, terpinoids and carotinoids:Classification, occurrence, isolation, characterization and chemistry of terpenes, biologically active terpenes. Terpenes as pharmaceutical raw materials.	6
	Plant pigments: Occurrence, classification, nomenclature, and structure, Chemistry of biologically important flavanoids, Flavanoids as raw materials.	6
	Pyrethroids and retinones: Occurrence, reactions, biological activity, structure and Chemistry	5
	Eicosanoids:Classifications, nomenclature, and chemical properties, and biological activity of Thromboxanes, Prostaglandins, Leukotrienes,	5
	Marine Natural Products: Introduction, occurrence and characteristic structural features, And structure of few marine products.	2
	Alkaloids and antibiotics will be covered elsewhere however An overview of these to be given.	2
	Porphyrins:Structure, general chemistry and properties, examples Haemoglobin, chlorophyll, cytochromes, etc.	2
	Few natural products from current literature that are having exciting Bioactivity to be discussed in general irrespective to which class they belong.	1
	<ul style="list-style-type: none"> Natural Products: chemistry and biological significance J. Mann, R.S. Davidson, et. Al. Insecticides of Natural Origin, Sukh Dev, Introduction to Flavanoids, B,A. Bohm, Many Organic chemistry and Medicinal chemistry books cover natural Products those can be referred. 	
4.	PHT1022-Physiopharmacology – II (50 marks) 3hr./week	
	CNS and drugs acting on CNS	8

	ANS and drugs acting on uterus, oral hypoglycemic, chemotherapy	12
	Drugs used in hypertensive, vasodilator, Immunopharmacology	10
5.	PHT1052–Medicinal Natural Products (50 marks) 3hr./week	
	Scope of the subject, Source of the drug of natural origin, Classification of drug, factors involved in the production of drugs.	8
	Phytochemistry Chemical constituents in the production of plants (carbohydrates, protein enzymes, lipids, alkaloids, glycosides, steroids, tannins, terpenoids, flavonoids, plant pigments, etc)	5
	Biosynthesis approach	3
	Extraction and isolation of plant drugs: conventional and modern techniques used in extraction and separation of phytoconstituents	3
	Commerce and quality control, application of spectroscopy and chromatography techniques for isolation, identification and analysis of phytoconstituents	5
	Detailed study of one representative from each of the above mentioned chemical class (10drugs)	5
	Recent advances in phytopharmaceuticals (topic of current interest)	1
6.	PHP1052-Medicinal Natural Products Laboratory (50 marks) 4hr./week	
	Medicinal Natural Products Laboratory Standardization of plant drugs using following methods (a) Morphology, microscopic quantitative microscopy, details microscopic study of drugs (b) Physical constants like: specific gravity, swelling factor, ash values, extractive values, refractive index, optical rotation, etc (c) Chemical methods identification tests for various classes of phytoconstituents, Extraction and isolation of active principles such as alkalis, glycosides, tannins, carbohydrates resin, essential oils, fats etc. from natural drugs (4-5drugs) and evaluation of isolated material by chromatography and spectroscopy.	
7.	PHP1071– Biochemistry Laboratory (50 marks) 4hr./week	
	Qualitative test for carbohydrates, confirmatory tests by osazone formation, Quantitative estimation of glucose by Wilstaters and Lane and Eynon method, estimation of sucrose, simple color reactions of proteins and amino acids, precipitation reactions of proteins; Determination of acid value and iodine value of lipids; enzymes: Ptyline activity of saliva	15

8.	PHP1072–Microbiology Laboratory (50 marks) 4hr./week	
	Study of microscopy, study of common laboratory equipment; Preparation and sterilization of nutrient broth, agar slants, stabs, plates; inoculation technique: Colony characteristics and growth patterns in broth of cocci and bacilli, Grams staining; monochrome staining, negative and vital staining; cell wall spore, capsule and flagella staining; motility by hanging drop technique; Microbial limit test, microbial assay, biochemical tests	

Detailed Syllabus for Third Year B. Tech (Pharma)

Semester V

Sr. No.	Topic	Hrs
1.	GET1104 – Chemical Engineering Operations (50 marks) 3hr./week	
2.	GET1104 – Chemical Reaction Engineering (50 marks) 3hr./week	
3.	PHT1042- Pharmaceutical Chemistry (50 marks) 3hr./week	
	Chemistry of heterocyclics of pharmaceutical interest: Structure, nomenclature, and reactivity	5
	Retrosynthetic analysis and synthesis: Idea and logic, terminologies, and strategies, transformation and functional group based strategies with examples of synthesis of drug molecules, building block based strategies with examples of synthesis drugs molecules, heterocyclic ring construction and drug synthesis, Synthesis of some drugs recently introduced to be covered	20
4.	Retrosynthetic analysis of relatively simple natural products and their Synthesis - to be selected from for example betalactam antibiotics, alkaloid drug, etc those regarded as classics in synthesis.	5
	<ul style="list-style-type: none"> • Organic Synthesis- The Disconnection Approach; Ed.: Warren S.; John Wiley & Sons-Chichester. • Organic Synthesis- The Disconnection Approach; Ed.: Warren S.; John Wiley & Sons-Chichester. • Organic Chemistry, Louden • Organic Chemistry, Carey • Classics in Organic Synthesis, K.C. Nicolaou • Logic of Chemical Synthesis, E.J. Corey 	
5.	PHT1061– Pharmaceutical Biotechnology (50 marks) 3hr./week	
	Application of Biotechnology in foods, pharmac, and other industries with special reference to enzymes	3
	Definitions, nomenclature and terminologies, isolation purification strain improvements, optimization of growth and product formation using industrially important micro organism	5
	Genetic engineering principles and technique	4

	Principles of surface and solid state fermentation, Design of different fermentors and the biochemical engineering aspects. Process control of fermentations.	8
	Fermentation technology of industrial chemicals, organic acids, amino acids, vitamins, polysaccharides, antibiotics, etc.	5
	Enzyme fermentation and technology including immobilization and enzyme reactors. Fermentative animals, and other developments	5
	<ul style="list-style-type: none"> • Principles of fermentation technology, Stanbury P. F. and Whitaker A. • Industrial microbiology, Prescott S. and Dunn C. • Elements of biotechnology, Gupta P.K. • Plant cell, Tissue and Organ culture, Gamburg O.L. and Phillips G. C. • Basic bioreactor design, Riet K. V. and Tramper J. • Bioreactor system design, Asenjo J. A. • Bioreactor immobilized enzymes and cells: fundamentals & applications, Moo-young M. • Industrial fermentations: Underkofler L. A. and Hickey R. J. Vol. I and II 	
6.	PHT1031 – Pharmaceutical Analysis (50 marks) 3hr./week	
	Raw materials for Pharmaceutical Industry	1
	Enzymes as catalyst (a) in Synthesis for Pharmaceuticals (b) Introduction to Principle of enzymes catalyst, Lipases and esterase's for hydrolytic conversion. Lipases and esterase's in organic solvents, other hydrolytic reactions, Enzyme-catalyzed oxidation reactions, Enzyme-catalyzed C-X bond synthesis, Enzyme-catalyzed reduction, Chiral Technology	14
	Chemical Development of enantiomerically pure products, resolution, chiral synthesis etc	2
	Separation (a) Aspect of Chemical Purification and process separation technology (b) Introduction to Separation technology; choosing a separation process, Adsorption Separation methods, Simulated moving bed (SMB) chromatography; Large scale chromatography; Homogeneous, Heterogeneous catalyst and phase transfer catalyst	8
	Mixing (a) Flow pattern and theories (impeller); suspension of solid particles; lipid- lipid dispersion; three phase dispersion; mass transfer at gas-liquid, solid-liquid, solid-solid, process design and scale up of mixing	5
	<ul style="list-style-type: none"> • Wolfgang Aehle, "Enzymes in Industry Production and Applications" Wiley VCH Publication, 2003 	

	<ul style="list-style-type: none"> • Heinrich Klefenz, “Industrial Pharmaceutical Biotechnology” Wiley-VCH Publication, 2002. • T. Scheper, “Process Integration in Biochemical Engineering” Springer Publication, 2003. • Oligan Repic, “Principles of Research and Chemical Development in the Pharmaceutical Industry Wiley Interscience 1998. • Romano Di Fabio, “From Bench to Market the Evolution Chemical Synthesis” Oxford University Press, 2000 	
7.	PHT1011 – Technology of Liquids and Topicals (50 marks) 3hr./week	
	Introduction and classification of pharmaceutical dosage forms	2
	Preformulation, formulation, evaluation, large scale manufacture and packaging with focus on equipment with reference to Liquid dosage forms; Monophasic solution syrups, elixirs, Nasal and ear drops etc.	6
	Biphasic suspensions and emulsions	10
	Topicals formulations: ointments, creams, gels	5
	Suppositories	3
	Layout design and Unit operations related to above dosage forms	4
	<ul style="list-style-type: none"> • Pharmaceutical Dosage Forms And Drug Delivery Systems, Ansel, Philadelphia, Fea and Febiger, 1985 • Introduction to Pharmaceutical Dosage Forms, Ansel, Henry Kimpton Publishers, London. • Pharmaceutical: The Science of Dosage Form Design, Aulton, New Delhi, B. I. Naverly Pvt. Ltd., 1995 • Dermatological Formulations, B. W. Barry, New York, Marcel Dekker 1983 • Modern Pharmaceutics, G. S. Banker, New York, Marcel Dekker 1990 • Bentely’s Textbook of Pharmaceutics, Rawlins, Cassell Ltd, London 	
8.	PHP1011– Technology of Liquid and Topicals (100 marks) 8hr./week	
	Preparation and evaluation of oral syrups, elixirs, tinctures, ear drops, nasal drops	
	Preparation and evaluation of suspensions/ dry syrup/emulsions of containing hydrophilic and hydrophobic drug	
	Preparation and evaluation of topical liniments and lotions	
	Preparation and evaluation of ointments representing each type of base, and gels	
	Preparation of suppositories (any 2 base)	
	Large scale manufacture of one monophasic and one biphasic liquid	
	<ul style="list-style-type: none"> • Pharmaceutical Prdouction Facilities: Design and Applications 	

	<p>G.C.Cole</p> <ul style="list-style-type: none"> • New York Ellis Horwood 1990 • Husa's Pharmaceutical Dispensing Martin E. W. Easton Mack Pub. Co. 1971 • Transdermal Delivery of Drug A. Kydonieus Florida, CRC Press, 1987 • Transdermal Controlled System Medications Y. W. Chien, New York, Marcel Dekker 1987 • The Theory and Practice of Industrial Pharmacy, Lachman Bombay, K. M. Warghese Co. 1976 • The Theory and Practice of Industrial Pharmacy, Lachman Bombay, K. M. Warghese Co. 1976 • Pharmaceutical Dosage Forms Vol. I & II, Liebermann, New York, Marcel Dekker, 1996. • Drug Delivery Devices: Fundamentals and Applications, Tyle New York, Marcel Dekker 1988 	
9.	PHP1031- Pharmaceutical Analysis (50 marks) 4hr./week	
	<p>Pharmaceutical Analysis Analysis of bulk actives, raw material, and active ingredients in formulation:</p> <ul style="list-style-type: none"> • Wet and instrumental methods • Structural analysis using spectra • Some specific tests from monographs 	
10.	PHP1061– Biotechnology Laboratory (50 marks) 4hr./week	
	<ol style="list-style-type: none"> 1. Preparation of Buffer 2. Immobilization of enzyme or yeast cells 3. Wine production 4. Strain improvement by UV survival (Mutation) 5. Separation of DNA by Gel Electrophoresis 6. Estimation of DNA and RNA 7. Microbiological assay – Penicillin Bioassay 8. MPN method of Water 9. Tissue culture 10. Lactic acid fermentation of Milk 11. Biochemical tests: Sugar Fermentation, Hydrolysis of Gelatin, Starch and Urea, Nitrate Reduction, Coagulase test, Oxidase Test, Catalase Test, IMIVC test 12. Factors affecting enzyme activity: Km, pH, Temperature, Vmax 	

Semester VI

Sr. No.	Topic	Hrs.
1.	CHT1341- Instrumentation (50 marks) 3hr./week	
2.	PHT1043 – Medicinal Chemistry-II (100 marks) 4hr./week	
	Antihistaminic including anti-ulcer drugs, emetics, antiemetics, Non-steroidal anti-inflammatory agents, antipyretics Anti-osteoporotic drugs,	10
	CVS-Drugs Cardiovascular drugs Diuretics, anticoagulants, thrombolytics and antithrombotics, cardiac agents, antihypertensive, antihyperlipidemics, local anesthetics, diagnostic agents anticancer agents, antiviral agents,	15 17
	Drugs acting on hormonal system	2
	(a) Ant diabetic agents	3
	(b) Steroid hormones-adrenocorticoids, antiinflammatory steroids	4
	(c) Sex steroids and antagonists, oral contraceptive, anabolic steroids	5
	(d) Thyroid and ant thyroid agents	2
	(e) Drugs acting on calcium homeostatic, iron preparation	2
	<ul style="list-style-type: none"> • Burger’s Medicinal Chemistry & Drug Discovery: Vol. 1 to 6; Ed.: A. Burger and M. E. Wolf; John Wiley & Sons-New jersey. • Foye’s Principles of Medicinal Chemistry; Ed.: W.O.Foye; Lippincott Williams & Wilkins-Philadelphia • Textbook of Medicinal and Pharmaceutical Chemistry; Ed.: Charles Owens Wilson; Lippincott Williams & Wilkins-Philadelphia., • Organic Synthesis- The Disconnection Approach; Ed.: Warren S.; John Wiley & Sons-Chichester. • Pharmaceutical Substances: Synthesis, Patents, Applications (N-Z); Ed: A. Kleemann; Georg Thieme Verlag-Stuttgart. • Strategies for Organic Drug Synthesis and Design; Ed.: Lednicer & Daniel; John Wiley & Sons Inc.-Inc.-New York. • Organic Chemistry of Drug Synthesis: Vol.1 to 6; Ed.: Daniel Lednicer; John Wiley & Sons Inc. New York. 	
3.	PHT1044- Drug Discovery Process and Drug Design (50 marks) 3hr./week	
	General introduction to drug discovery, molecular discovery to market	5

	<p>to be discussed, meaning of hit, lead, lead development, toxicity study, various phases of clinical trials, synthetic methods, ADME, entire gamut including filing of various applications and approvals to be covered with significance of each aspect. Objective is to expose the students to the entire process and details to be covered accordingly.</p> <p>Introduction to various sources and approaches for new chemical entities, (Coverage to be at appropriate depth and level with suitable examples)</p> <p>Drug Receptor interaction, drug action theories, classification of receptor outline, General screening approaches outline.</p> <p>source: Medicines used in folklore and traditional system of treatment and their regulatory requirements to market, concept of reverse pharmacology and an approach for drug discovery.</p> <p>a) Random screening approach, methodology. 2</p> <p>b) Analog design and tools: SAR, QSAR, CADD - Molecular modeling, bioisosterism and other concepts 2</p> <p>c) SBDD: general concept, molecular modeling, docking 2</p> <p>d) Fragment based drug design, 2</p> <p>e) Enzyme inhibitors as drugs</p> <p>f) Meaning of lead optimization and general approaches</p>	<p>4</p> <p>2</p> <p>2</p> <p>9</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>
	<ul style="list-style-type: none"> • Burger's Medicinal Chemistry & Drug Discovery: Vol. 1 to 6; Ed.: A. Burger and M. E. Wolf; John Wiley & Sons-New jersey. • Foye's Principles of Medicinal Chemistry; Ed.: W.O.Foye; Lippincott Williams & Wilkins-Philadelphia • Textbook of Medicinal and Pharmaceutical Chemistry; Ed.: Charles Owens Wilson; Lippincott Williams & Wilkins-Philadelphia., • Comprehensive Medicinal Chemistry Series. 	
4.	PHT1012- Technology of Solid Dosage Forms (50 marks) 3hr./week	
	Preformulation, Formulation, Evaluation, Large scale manufacture and packing with focus on equipment with reference to Tablets	12
	Coated tablets	6
	Capsules: Hard gelatin and soft gelatin, microcapsules	8
	Layout design and Unit operations related to above dosage forms	4
	<ul style="list-style-type: none"> • Remington's Pharmaceutical Sciences, A. R. Gennaro Mac Pub. Co. Easton, Pennsylvania 1990. • Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia • Coated Pharmaceutical Dosage Forms, K. H. Bauer, CRC Press, Boca Raton. Med Pharm. • Pharmaceutical Coating Technology, G. C. Cole, New York, 	

	<p>Ellis, Horwood, 1990</p> <ul style="list-style-type: none"> • Pulsed and Self-Regulated Drug Delivery, J. Kost, Florida, CRC Press, 1987 • Extended Release Dosage Forms, - Klow Czynski, Florida, CRC Press, 1987 • Treatise on Controlled Drug Delivery, A. Kydonieus CRC Press 1987 • The Theory and Practice of Industrial Pharmacy, Lachman, Bombay, K. M. Warghese Co. 1976 • Pharmaceutical Dosage Forms Vol. I & II, Liebermann, New York, Marcel Dekker, 1996. • Hard Capsules: Development and Technology, K. Ridgway, London Pharmaceutical Press 1987 	
5.	PHT1045– Catalysis and Catalytic Processes (50 marks) 3hr./week	
	Raw materials for Pharmaceutical Industry	1
	<p>Enzymes as catalyst</p> <p>(a) in Synthesis for Pharmaceuticals</p> <p>(b) Introduction to Principle of enzymes catalyst, Lipases and esterase's for hydrolytic conversion. Lipases and esterase's in organic solvents, other hydrolytic reactions, Enzyme-catalyzed oxidation reactions, Enzyme-catalyzed C-X bond synthesis, Enzyme-catalyzed reduction, Chiral Technology</p>	14
	Chemical Development of enantiomerically pure products, resolution, chiral synthesis etc	2
	<p>Separation</p> <p>(a) Aspect of Chemical Purification and process separation technology</p> <p>(b) Introduction to Separation technology; choosing a separation process, Adsorption Separation methods, Simulated moving bed (SMB) chromatography; Large scale chromatography; Homogeneous, Heterogeneous catalyst and phase transfer catalyst</p>	8
	<p>Mixing</p> <p>(a) Flow pattern and theories (impeller); suspension of solid particles; lipid- lipid dispersion; three phase dispersion; mass transfer at gas-liquid, solid-liquid, solid-solid, process design and scale up of mixing</p>	5
6.	Elective-I PHT 1062 Recombinant DNA Technology (50 marks) 3hr./week	
	DNA Vectors: Cosmid vectors, Plasmids, BAC's, PACs. Choice of vectors. Vectors for making ssDNA for sequencing, Expression vectors, Vectors for making RNA probes, Vectors for maximizing protein synthesis, Vectors to facilitate protein purification, vectors to	10

	promote protein solubilization and Vectors to promote protein export.	
	Cloning strategies: Cloning genomic DNA, PCR as an alternative to genomic DNA cloning, cDNA cloning, Phage- λ vectors for cDNA cloning and expression, Preparation of cDNA for library construction, Full length cDNA cloning, ESTs for high-throughput genome research, sequence dependent screening, Screening strategies, Difference cloning Fate of DNA introduced in fungi, Plasmid vectors for use in fungi, choice of vector for cloning, Expression of cloned genes, over expression of proteins in fungi, Specialist vectors, Yeast surface display, Detecting protein-protein interactions.	6
	Gene transfer to animal cells: Overview of gene-transfer strategies, Transformation techniques, Transformation with non-replicating DNA, Reporter genes and promoter analysis, Transformation with replicon vectors, Gene transfer by viral transduction.	6
	Molecular structure and chemical biology in pharmacy: Molecular biology of diseases and in-vivo transgenic models, genomic protein targets and recombinant Therapeutics Rational Drugs design. Chemical biology and molecular diversity. DNA/ RNA targeted therapeutics.	6
	Recent Advances in rDNA technology	2
	<ul style="list-style-type: none"> • Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition Author: Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten Book ISBN or Item Number: 978-1-55581-498-4 • Principles of gene manipulation and genomics S. B. Primrose, Richard M. Twyman C. An Introduction To Molecular Biotechnology: Molecular Fundamentals, Methods And Applications In Modern Biotechnology Michael Wink • Cell and Molecular Biology: Concepts and Experiments Gerald Karp • Discovering Genomics, Proteomics and Bioinformatics (2nd Edition) [Paperback] Malcolm Campbell 	
7.	CHP1342– Chemical Engineering Laboratory (50 marks) 4hr./week	
8.	PHP1042– Pharmaceutical Chemistry Laboratory (100 marks) 8hr./week	
	Preparation of compounds in common use in pharmaceutical industry-simple transformation using newer reagents (1- exercise) Concise writing of procedures and presentation for selected reaction from the latest literature (5 examples)	

9.	PHP1012– Solid Dosage Forms Laboratory (50 marks) 4hr./week	
	<p>Solid Dosage Forms</p> <ul style="list-style-type: none"> (a) Preparation and evaluation of tablets of the following types: conventional, chewable, effervescent, soluble, dispersible, mouth dissolve, using different binders/granulation methods (b) Filling and evaluation of hard gelatin capsules (c) Micro encapsulation of liquids and solids (d) Large scale manufacture and evaluation of tablets (demonstration) (e) Coating of tablets (demonstration) (f) Evaluation of coated tablets 	

Detailed Syllabus for Final Year B. Tech (Pharma)

Semester VII

Sr. No.	Topic	Hrs
1.	GET1104 – Project Economics (50 marks) 3hr./week	
2.	GET1104 – Industrial Psychology and Human Resource Management (50 marks) 3hr./week	
3.	PHT1046 – Process Technology Drug and Intermediates (50 marks) 3hr./week	
	Manufacturing processes for drugs involving multiple steps and comparative study of various routes of synthesis	10
	Introduction, the chemical process life-cycle, Legislative requirements for safe process development and scale up, Development techniques for safe process design, Unit operations posing particular hazards during development, Strategies for chemical hazards assessment, Hazards of gas and vapor generation, Identification of highly-energetic materials, Small scale screening tests; case studies, Flammability issues associated with chemical manufacture, Gas and Vapor pressure systems, Process control consideration and safety critical systems, GMP in chemical development	5
	Optimization of Organic Reactions and Processes (a) Introduction-the purpose of chemical development, Discovering the best synthetic route; Selecting the best route for scale-up, Choice of raw materials, reagents etc; case studies, The investigative approach to chemical development, Effect of process variables on yield and quality of products; Quality control in process analysis as an aid to optimization, Designing a robust process and preventing scale-up problems, Solvent effects, Work up and product isolation, Selecting the parameters to vary, Planning for scale up, Design of environmentally friendly processes, Effluent minimization and control, Statistical methods of optimizations.	15
	<ul style="list-style-type: none"> • A. Liese, “Industrial Bio transformations” Wiley-VCH 2000 • Mahmoud M. “Pollution Prevention Through Process Integration (Systematic Design Tools)” Academic Press, 1997 • Neal G. Andreson, “Practical Process Research and Development” academic Press, 2000 • A. Cybulski, “Fine Chemicals Manufacture- Technology and Engineering Elsevier Publication, 2000 	

	<ul style="list-style-type: none"> • “Mixing Equipment (Impeller type)” AIChE Publication 2001 • “Chemical Process Quantitative Risk Analysis” AIChE Publication, 2000 	
4.	PHT1013 – Validation and Regulatory Requirements (50 marks) 3hr./week	
	CGMP and Quality assurance, Schedule M	6
	Process, product validation and quality audits. Documentation	9
	New drug application (NDA), generic products(ANDA), Schedule Y	3
	DPCO, drugs and cosmetics act and rules including licensing intermediates industry	12
	<ul style="list-style-type: none"> • Beotra’s Law of Drugs Medicins and Cosmetics K. K. Singh, L. R. Bugga for the Law Book Co. Pvt. Ltd. Allahabad • Modern Pharmaceutics, G. S. Banker, New York, Marcel Dekker 1990 • Fundamentals of Pharmacy, Blome H. E., Philadelphia, Fea and Febiger, 1985 • Pharmaceutical Production Facilities: Design and Applications, G. C. Cole, New York Ellis Horwood 1990 • Drug Delivery Devices: Fundamentals and Applications Tyle, New York, Marcel Dekker 1988 • Microbial Quality Assurance in Pharmaceuticals Cosmetics and Toiletries, S. F. Bloomfield, Chichester, Ellis, Horwood, 1998. • Encyclopedia of Pharmaceutical Technology, J. Swarbrick, New York, Marcel Dekker, 1993 • Remington’s Pharmaceutical Sciences, A. R. Gennaro Mac Pub. Co. Easton, Pennsylvania 1990 • Indian Pahrmacopoiea, British Pahrncopoiea, United States Pharmcopoiea. • Oral Mucosal Drug Delivery, Rathbone, New York, Marcel Dekker, 1996 • Good Laboratory Practice Regulations A. F. Hirsch, New York, Marcel Dekker, 1989 • Good Laboratory Practice Regulations Weinberg New York, Marcel Dekker, 1995. 	
5.	PHT1014 – Technology of Sterile Products (50 marks) 3hr./week	
	Formulation, Formulation, Evaluation, Large scale manufacture and packing with focus on equipment with reference Parenterals	12
	Ophthalmics	4
	Layout design and freeze drying related to above dosage forms	4
	Blood products, Glandular products, medical sutures, ligatures	5
	Stability evolution of Pharmaceutical dosage forms	5
	<ul style="list-style-type: none"> • Dispensing for Pharmaceutical Students, Cooper and Gunn, 	

	<p>London, Pitman Medical Pubs. Co. 1965</p> <ul style="list-style-type: none"> • Therapeutic Systems: Pattern-Specific Drug Delivery, Heilmann, Struttgart, G. Thiense Pub. 1978 • Encyclopedia of Pharmaceutical Technology, J. Swarbrick, New York, Marcel Dekker, 1993 • Remington's Pharmaceutical Sciences, A. R. Gennaro Mac Pub. Co. Easton, Pennsylvania 1990 • Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia. • Theory & Practice of Industrial Pharmacy. L. Lachman, Herbert A.Lieberman & J. Kanig, Lea & Febiger, Philadelphia, 1987 • Pharmaceutical Dosage Form: Dispersed Systems (Vol.1 &2) HerberA. Lieberman, Martin A.Rieger,G.S.Ban, Marcel Dekker Inc., 1993 • Modern Pharmaceutics. Gilbert S.Banker, C.T. Rhodes, Marcel Dekker Inc.1990 • Pharmaceutics: The Science of Dosage Form Design. Michael E.Aulton, Churchill-Livingstone, 1998 • Pharmaceutical Dosage forms: Parenteral Medications in Three volumes, Kenneth E. Avis, Herbert A. Lieberman, Leon Lachman, Marcel Dekker Inc.1993 	
6.	PHT1047– Structural Analysis by Spectroscopy (50 marks) 3hr./week	
	<p>Ultraviolet and Visible Spectrophotometry: Electronic transition, spectrum, shift of bands with solvents, isolated double bonds, conjugated dienes, carbonyl compounds, and aromatic compounds. Single and multicomponent quantitative analysis (including derivative spectroscopy) Application of UV in structure determination including Woodward Fischer rules.</p>	6
	<p>Infrared Spectroscopy: Molecular Vibrations, Frequency shifts associated with structural changes; Basic theory of FTIR spectroscopy, Qualitative and quantitative analysis using infrared spectroscopy. Interpretation of IR spectra and application of IR in structure determination.</p>	4
	<p>Nuclear Magnetic Resonance: Basic principles of NMR phenomenon, relaxation processes, spin-spin interaction, chemical shifts, interpretation of NMR spectra. Application of NMR in structure determination.</p>	10
	<p>Mass spectroscopy: Basic principles, ionization of a molecule on electron impact, fragmentation processes in organic compounds, interpretation of mass spectra, molecular formula and mass; Instrumentation-different</p>	6

	types of ionization sources and magnetic analyzer. Interpretation of MS and application in structure determination.	
	Problems in structure determination using an integrated approach – the four spectroscopic techniques of UV, IR, NMR and MS.	4
	<ul style="list-style-type: none"> • Applications of Absorption Spectroscopy of Organic Compounds, John R Dyer, Prentice Hall, India, 1987. • Organic Structural Analysis, Lambert, J.B., Macmillan Publisher, New York, 1976. • Organic Spectroscopy, Kemp W., 3rd ed., Palgrave, 1991. • Spectroscopic methods in Organic Chemistry, Williams D.H. and Fleming I., 4th ed., McGraw-Hill Book Co., New Delhi, 1987. • Spectroscopic identification of Organic compounds, Silverstein R.M., Bassler G.C., Morill T.C., John Wiley and Sons, 1991. 	
7.	PHP1046– Process Technology Laboratory (100 marks) 8hr./week	
	Synthesis of drugs involving two or more steps (a) with analysis of raw materials and product synthesis (b) in process control and reaction monitoring	
	Any innovative modifications in the process of drug synthesized (2 examples) and no repetition of the same from previous years	
	Bioconversions.	
8.	PHP1014– Sterile Products Laboratory (50 marks) 4hr./week	
	<p>Sterile Product</p> <p>(a) Preparation and evaluation of injectables formulations to represent types(solution, suspension, emulsion), different methods of sterilization, tonicity adjustment</p> <p>(b) Preparation and evaluation of one LVP</p> <p>(c) Monographic testing of water for injection</p> <p>(d) Evaluation of parenteral containers and closures</p> <p>(e) Preparation and evaluation of eye drops and eye ointments</p> <p>(f) Workshop on accelerated stability testing</p>	
19.	PHP1071– Seminar (50 marks) 4hr./week	

Semester VIII

Sr. NO.	Topic	Hrs.
1.	CHT1341- Industrial Management (50 marks) 3hr./week	
2.	PHT1042- Value Education (50 marks) 3hr./week	
3.	PHT1061– Design and Analysis of Experiments (50 marks) 3hr./week	
4.	PHT1015- Drug Delivery Systems (50 marks) 3hr./week	
	Performulation, Formulation, Evolution, Large scale manufacture and packing with focus on equipment with reference to Oral sustained and controlled release dosage forms	10
	Aerosols	4
	Introduction to Novel drug Delivery Systems: Transdermal, Transmucosal(buccal, sublingual, nasal, vaginal, rectal), Ophthalmic, Colloidal: Liposome's, nanoparticles, emulsion systems etc	12
	Introduction to Radio pharmaceuticals, Overview of cosmetic products	4
	<ul style="list-style-type: none"> • Pharmaceutical Dosage Forms And Drug Delivery, Systems, Ansel, Philadelphia, Fea and Febiger, 1985 • Introduction to Pharmaceutical Dosage Forms Ansel, Henry Kimpton Publishers, London. • Pharmaceutics: The Science of Dosage Form Design Aulton, New Delhi, B. I. Naverly Pvt. Ltd., 1995 • Modern Pharmaceutics G. S. Banker New York Marcel Dekker 1990 • Bentely's Textbook of Pharmaceutics Rawlins Cassell Ltd, London • Fundamentals of Pharmacy Blome H. E. Philadelphia, Fea and Febiger, 1985 • Fundamentals of Pharmacy Blome H. E. Philadelphia, Fea and Febiger, 1985 • Pharmaceutic Production Facilities: Design and Applciations G. C. Cole • New York Ellis Horwood 1990 	

	<ul style="list-style-type: none"> • Husa's Pharmaceutical Dispensing Martin E. W. Easton Mack Pub. Co. 1971 • Transdermal Delivery of Drug A. Kydonieus Florida, CRC Press, 1971 • Transdermal Controlled System Medications Y. W. Chien, New York, Marcel Dekker 1987 • Theory & Practice of Industrial Pharmacy. L. Lachman, Herbert A. Lieberman & J. Kanig, Lea & Febiger, Philadelphia, 1987 • Pharmaceutical Dosage Form: Dispersed Systems (Vol.1 &2) Herber A. Lieberman, Martin A. Rieger, G.S. Ban, Marcel Dekker Inc., 1993 • Modern Pharmaceutics. Gilbert S. Banker, C.T. Rhodes, Marcel Dekker Inc. 1990 • Pharmaceutics: The Science of Dosage Form Design. Michael E. Aulton, Churchill-Livingstone, 1998 	
5.	PHT1016-Nanoscience and Technology (50 marks) 3hr./week	
	Definitions, classification of nanostructures and systems, nanotechnology and pharmaceutical applications(Introduction)	3
	Nanoscale properties as a function of size: structural properties, chemical properties, mechanical properties, thermal properties, optical properties, magnetic properties, electronic properties	5
	Fabrication methods(general approaches): Top-down, bottom-up and templating approaches	5
	Characterization methods(general aspects of each methods to be covered rather than in depth): Imaging(microscopy) methods, analysis(spectroscopy) methods, size measurements etc	5
	Self-assembling nanostructure: principle of self assembly(non-covalent inter actions and intermolecular packing), preparation and characterization of Nanoparticles through vesicular and micellar polymerization, nanofilms	5
	Gold and silver Nanoparticles: preparation, properties and pharmaceutical/healthcare applications	3
	Molecular nanomaterials: dendrimers	1
	Nanotechnology in catalysis: nanostructure and catalysis - fundamental principles, examples of nanocatalyst based synthetic methodologies	3
	<ul style="list-style-type: none"> • Nanoscale Science and Technology; R. Kesall, I. Hamley, M. Geoghegan; • Nanobiotechnology(Concepts, applications and perspectives); C.M. Niemeyer and C.A. Mirkin; Nanotechnology in catalysis Vol 1 & 2, B. Zhou, S. Hermans and G.A. Somorjai; • Teacher shall prescribe some latest review articles. 	

6.	PHT1017– Pharmaceutical Packaging Technology (50 marks) 3hr./week	
	Introduction to Packaging, Classification of Packaging, Essential Requirements, Functions of Packaging, Importance / significance of Pharma Packaging, Properties of Ideal Package, Packaging formats in Pharma Industry, Packaging recycling symbols, FDA Definitions	2
	Introduction to Packaging materials, Classification of Packaging materials, Approach to package design, New Trends in the pharmaceutical packaging	2
	Introduction to plastics and polymers, Raw Materials of Plastics, Types of Plastics, Resin identification code, Plastics and Packaging, testing of plastic containers	2
	Introduction to glass, Selection of glass as packaging materials for the pharmaceutical products , Advantages and disadvantages of glass containers ,Properties of glass, Production of glass, Types of glass, Manufacturing of Glass containers, Testing of glass containers	3
	Introduction to metals, Aluminium and Aluminium foil , Collapsible Tubes ,Tin, Stainless steel	1
	Introduction to blister package, Blister design parameters, Materials, Formation, Types of Blisters, Advantages and disadvantages of Blister Packaging, Types of Problems/ Defects, Blister Packing Machine, Other packages, Strip Packs- High Barrier Laminates, Strip Packaging Process, Properties of Materials, Child-resistant strip package, Strip Sealing Machine, Strip Packing Machinery, Multi-Dose Strip Packaging	3
	Introduction to Ancillary Materials used in Packaging, Adhesives , Paper , Paperboard, Wood, fibreboard , Packaging inserts , leaflets	1
	Introduction to natural and synthetic rubber, Types of closures, Classification of contemporary closures by their utility, Special-purpose Closure, Closure Functions, Closure Materials, Types of Plastic Closures, Sealing Systems, Liners, Closure Liner Functions, Classification of Liners, Selection of Lining Material, Options for Closure Liners, Innerseals, Linerless Closures, Types of tapes, Strapping Materials, Evaluating Closure Liners, Standard Liners, Taseal, Solutions, Liner Description, Liner Designations	3
	Introduction, Components of Corrugated fibre board, Types of Corrugated Board, Advantages & Disadvantages, Manufacturing, Box Structure, Box Dimensions, Types of Box, Applications of C.F.B., New developments in CFB	2
	Sterilization of packaging materials Introduction, Pharmaceutical Importance of Sterilization, Physical and Chemical Factors that affect sterilization, Terms commonly used, Classification of Sterilization Methods, Sterilization of Packaging Materials, Tests for Sterility , Incubation and examination of sterility tests, Interpretation of the test results, Evaluation of Sterilization Method, Process of Microbial Destruction, Evaluation	2

	and In Process Monitoring of Sterilization Procedures	
	Packaging of Parenterals, Ophthalmics, And Aerosols Introduction, Packaging of Sterile Pharmaceuticals, Packaging Components, Inspection of Filled Injectable Products, Storage and Labelling, Packaging of Ophthalmics, Selection of Packaging Materials, Packaging of Aerosols	3
	Defects In Packages Introduction, Defects in Packaging Material	1
	Package Testing And Testing of Containers & Closures Introduction, Testing of containers and closures	2
	Stability of Packages Introduction, Legislation, Regulation, Pharmaceutical Stability Testing in Climatic Cabinets, Pharmaceutical Stability Testing Conditions, Photo-Stability Testing, Review of Pharmaceutical Product Stability, Packaging and the ICH Guidelines	2
	Packaging Regulations And Legal Requirements	1
	<ul style="list-style-type: none"> • D. A. Dean, Roy Evans, Ian Hall. Pharmaceutical packaging technology. Tylor and Francis. • Edward J. Bauer, Pharmaceutical Packaging Handbook. Bausch and Lomb, Rochester, New York, USA. • Wilmer A. Jenkins, Kenton R. Osborn. Packaging drugs and pharmaceuticals. • Salvatore J. Turco, Sterile dosage forms: their preparation and clinical application • Remington: The Science and Practice of Pharmacy. • Michael E. Aulton, Kevin Tylor (Ed.). Aulton's Pharmaceutics: The design and Manufacture of Medicine. • Gilbert Banker and Christopher Rhodes. Modern Pharmaceutics. • Leon Lachman; Lieberman Herbert A.; Kanig, Joseph L. The theory and Practice of Industrial Pharmacy. 	
7.	PHP1016– Green Chemistry Laboratory (50 marks) 4hr./week	
	Minimum 10 experiments to illustrate the principles of green chemistry/technology. The experiments may include, greener version(S) of classical reactions such as, N-acetylation, O-acetylation, etherification, esterification, bromination, iodination, oxidation, reduction, rearrangement(S) such Beckmann etc , and use of ionic liquid as green solvents.	
8.	PHP1072- Experimental Project (150 marks) 12hr./week	