Semester V

Course Code	Name of the course	No. of hours per week (L/P)	Credit points
BP501T	Biomedicinal Chemistry (Theory)	3	3
BP502T	Industrial Pharmacognosy (Theory)	3	3
BP503T	Innovation and Startup Ecosystem (Theory)	2	2
BP504T	Pharmaceutical Dosage Form II (Theory)	2	2
BP505T	Pharmaceutical Quality Assurance (Theory)	3	3
BP506T	Systemic Pharmacology II (Theory)	3	3
BP507P	Biomedicinal Chemistry (Practical)	4	2
BP508P	Industrial Pharmacognosy (Practical)	3	1
BP509P	Pharmaceutical Dosage Form II (Practical)	3	1
BP510P	Systemic Pharmacology II(Practical)	4	2
Total		**30**	**22**

Course Code	Course Title		Course Type	
BP501T	**Biomedicinal Chemistry (Theory)**		Core	
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
3	3	--	--	45
Maximum Marks	SE		ESE	
75	30		45	

COURSE OBJECTIVES:

The objectives of this course are to:

1. Provide comprehensive knowledge of drugs acting on the central nervous system, including anesthetics, sedatives, antipsychotics, and anticonvulsants, with emphasis on their chemical classification and structure–activity relationships (SAR).
2. Familiarize students with anti-infective chemotherapeutic agents used against tuberculosis, malaria, protozoal, viral, fungal, helminthic, and urinary tract infections, including their chemical structures and SAR.
3. Impart understanding of antibiotics and sulfa drugs, focusing on their chemical classes, mechanisms, therapeutic relevance, and structure–activity relationships.
4. Introduce antineoplastic agents and endocrine drugs, highlighting their chemical nature, classification, therapeutic applications, and structure–activity correlations.
5. Develop knowledge of antidiabetic agents and narcotic analgesics, including opioid antagonists, with emphasis on medicinal chemistry principles and SAR of key drug classes.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Classify and explain the chemistry, therapeutic use, and structure–activity relationships of drugs acting on the central nervous system, including anesthetics, sedatives, antipsychotics, and anticonvulsants.
2	Describe the chemical classification, mechanism of action, and SAR of major anti-infective agents such as antituberculars, antimalarials, antivirals, antifungals, anthelmintics, and urinary tract anti-infectives.
3	Analyze the chemistry and SAR of antibiotics and sulfonamides and correlate structural features with antimicrobial activity and spectrum of action.
4	Explain the chemical basis, therapeutic significance, and SAR of antineoplastic agents and endocrine drugs used in cancer and hormonal disorders.
5	Interpret the chemistry, pharmacological relevance, and SAR of antidiabetic agents and narcotic analgesics, including opioid agonists and antagonists, for rational drug use and development.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
	*Study of the development of the following classes of drugs includes chemical classification, structure, uses, SAR of selective drug classes, and synthesis of selected drugs as superscripted**	
I	**Drugs Acting on the Central Nervous System** **General Anesthetics** Halothane, Methoxyflurane, Enflurane, Sevoflurane, Isoflurane, Desflurane, Methohexital, Thiamylal, Thiopental, Ketamine*, Ramelteon, Remimazolam, Fospropofol, Dexmedetomidine **Sedatives and Hypnotics** Barbital, Phenobarbital*, Mephobarbital, Amobarbital, Butabarbital, Pentobarbital, Secobarbital, Chlordiazepoxide, Diazepam*, Oxazepam, Chlorazepate, Lorazepam, Alprazolam, Zolpidem, Glutethimide, Meprobamate, Ethchlorvynol, Triclofos, Paraldehyde SAR of Barbiturates and Benzodiazepines **Antipsychotics** Promazine, Chlorpromazine*, Triflupromazine, Thioridazine, Piperacetazine, Prochlorperazine, Trifluoperazine, Chlorprothixene, Thiothixene, Loxapine, Clozapine, Haloperidol, Droperidol, Risperidone, Molindone, Sulpiride, Brexpiprazole, Lumateperone, Pimavanserin, Samidorphan SAR of Phenothiazines **Anticonvulsants** Phenobarbitone, Methabarbital, Phenytoin*, Mephenytoin, Ethotoin, Oxazolidinediones: Trimethadione, Paramethadione Succinimides: Phensuximide, Methsuximide, Ethosuximide Phenacemide, Carbamazepine*, Clonazepam, Primidone, Valproic acid, Gabapentin, Felbamate, Perampanel, Lacosamide, Retigabine SAR of Anticonvulsants	10 Hours
II	**Anti-Infective Chemotherapeutic Agents** **Antitubercular Agents** Isoniazid*, Ethionamide, Ethambutol, Pyrazinamide, Para-amino salicylic acid*, Rifampicin, Rifabutin, Cycloserine, Streptomycin, Capreomycin, Pretomanid, Clofazimine, Levofloxacin, Bedaquiline, Linezolid, Delamanid **Antimalarials** Quinine, Chloroquine*, Amodiaquine, Primaquine, Pamaquine, Quinacrine, Mefloquine, Cycloguanil pamoate, Proguanil, Pyrimethamine, Artesunate, Artemether, Atovaquone	12 Hours

	SAR of Quinoline derivatives **Antiprotozoals** Metronidazole*, Tinidazole, Ornidazole, Diloxanide, Iodoquinol, Pentamidine isethionate, Atovaquone,Eflornithine, Paromomycin, Nitazoxanide **Antivirals** Amantadine, Rimantadine, Idoxuridine, Acyclovir*, Ganciclovir, Zidovudine, Didanosine, Zalcitabine, Lamivudine,Loviride, Delavirdine, Ribavirin, Saquinavir, Indinavir, Ritonavir, Valganciclovir, Peramivir, Lenacapavir **Antifungals** Amphotericin-B, Nystatin, Natamycin, Griseofulvin, Clotrimazole, Econazole, Butoconazole, Oxiconazole, Tioconazole, Miconazole, Ketoconazole*, Terconazole, Itraconazole, Fluconazole, Naftifine, Tolnaftate, Posaconazole, Isavuconazole **Anthelmintics** Diethylcarbamazine, Thiabendazole, Mebendazole, Albendazole*, Niclosamide, Oxamniquine, Praziquantel, Ivermectin **Urinary Tract Anti-infective Agents** Nalidixic acid, Norfloxacin, Enoxacin, Ciprofloxacin*, Ofloxacin, Lomefloxacin, Sparfloxacin, Gatifloxacin, Furazolidone, Nitrofurantoin, Methenamine, Moxifloxacin SAR of Quinolones	
III	**Antibiotics and Sulfa Drugs** **Antibiotics** Penicillins, Cephalosporins, β-Lactamase inhibitors, Monobactams Aminoglycosides: Streptomycin, Neomycin, Kanamycin, Tetracyclines: Tetracycline, Oxytetracycline, Minocycline, Doxycycline, Macrolides: Erythromycin, Clarithromycin, Azithromycin Chloramphenicol*, Clindamycin, Clavulanic acid SAR of Penicillins, Tetracyclines, and Cephalosporins **Sulfa Drugs** Sulphamethizole, Sulfisoxazole, Sulphapyridine, Sulphathiazole, Sulfacetamide, Sulphamethoxazole,Sulphadiazine, Mefenide, Sulfasalazine, Trimethoprim, Cotrimoxazole, Dapsone* SAR of Sulfonamides	8 Hours
IV	**Antineoplastic Agents** Mechlorethamine, Cyclophosphamide, Melphalan, Chlorambucil, Busulfan, Thiotepa, Mercaptopurine*, Thioguanine, Fluorouracil, Floxuridine, Cytarabine, Methotrexate*, Azathioprine, Dactinomycin, Daunorubicin, Doxorubicin, Bleomycin, Etoposide, Vinblastine, Vincristine, Paclitaxel, Camptothecin, Cisplatin, Mitotane, Carboplatin	6 Hours
V	**Endocrine Drugs, Antidiabetic Agents and Narcotic Analgesics** **Endocrine Drugs**	9 Hours

	Sex hormones: Testosterone, Nandrolone, Progesterone, Oestriol, Oestradiol, Oestrone, Diethylstilbestrol Drugs for erectile dysfunction: Sildenafil, Tadalafil Oral contraceptives: Mifepristone, Norgestrel, Levonorgestrel Corticosteroids: Cortisone, Hydrocortisone, Prednisolone, Betamethasone, Dexamethasone Thyroid and antithyroid drugs: L-Thyroxine, L-Thyronine, Propylthiouracil, Methimazole **Antidiabetic Agents** Insulin and preparations, Tolbutamide*, Chlorpropamide, Glipizide, Glimepiride Biguanides: Metformin Thiazolidinediones: Pioglitazone, Rosiglitazone Repaglinide, Nateglinide, Acarbose, Voglibose **Narcotic Analgesics** Morphine, Codeine, Meperidine, Anilerdine, Diphenoxylate, Loperamide, Fentanyl*, Methadone, Propoxyphene, Pentazocine, Levorphanol Nalorphine, Levallorphan, Naloxone SAR of Morphine analogues	

Recommended References (Preferably latest editions):

1. Abraham, D. J. and Griffin, J. L. *Burger's Medicinal Chemistry and Drug Discovery.* Wiley.
2. Brunton, L., Hilal-Dandan, R. and Knollmann, B. *Goodman and Gilman's The Pharmacological Basis of Therapeutics.* McGraw-Hill Education.
3. Kar, Ashuthosh. *Medicinal Chemistry.* New Age International.
4. Lednicer, D. *The Organic Chemistry of Drug Synthesis.* Wiley.
5. Li, J. J. *Modern Drug Synthesis.* Wiley.
6. Patrick, G. L. *An Introduction to Medicinal Chemistry.* Oxford University Press.
7. Vogel, A. I. *Vogel's Textbook of Practical Organic Chemistry.* Pearson Education.
8. Williams, D. A., Lemke, T. L. and Roche, V. F. *Foye's Principles of Medicinal Chemistry.* Lippincott Williams & Wilkins.
9. Wilson, C. O., Beale, J. M. and Block, J. H. *Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry.* Lippincott Williams & Wilkins.

Course Code	Course Title		Course Type	
BP502T	**Industrial Pharmacognosy (Theory)**		Core	
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
3	3	--	--	45
Maximum Marks	SE		ESE	
75	30		45	

COURSE OBJECTIVES:

The objectives of this course are to:

1. Introduce students to the industrial, commercial, and economic aspects of herbal drugs in national and global markets.
2. Knowledge of commercial production, quality assurance, and standardization of herbal extracts, volatile oils, and traditional AYUSH formulations
3. Train students in modern analytical techniques for the identification, characterization, and quality evaluation of plant-based drugs and herbal products
4. Develop skills in isolation, characterization, commercial production, and analysis of bioactive phytoconstituents.
5. Familiarize students with national and international regulatory frameworks, pharmacopoeial standards, and safety, efficacy, and pharmacovigilance requirements governing herbal medicinal products.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Describe the economic significance, trade potential, emerging therapeutic categories, and institutional support for medicinal and aromatic plant–based industries at national and international levels.
2	Explain the principles of commercial production, standardization, and quality control of herbal extracts, volatile oils, cosmeceuticals, and traditional formulations in compliance with AYUSH, WHO-GMP, and global regulatory norms.
3	Demonstrate analytical competence in evaluating herbal drugs and botanicals using modern spectroscopic and chromatographic techniques such as UV, IR, NMR, MS, HPTLC, HPLC, UPLC, and GC.
4	Describe the process to isolate, characterize, identify, and analyze important phytoconstituents used in pharmaceutical, nutraceutical industries.
5	Interpret and apply international regulatory guidelines, pharmacopoeial monographs, and safety, efficacy, and pharmacovigilance requirements for herbal and traditional medicinal products

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
I	**General Introduction to Herbal Industries, institutions and trade status of herbals** (a) Role of medicinal and aromatic plants trade in national economy of a country and introduction of Current trade status and potential of some commercially important medicinal plants/natural products like Ashwagandha, Turmeric, Ginseng, Amla and essential oils. (b) A brief account of bioeconomy, biodiversity hot spots and plant-based industries and institutions involved in research work on medicinal and aromatic plants in India. (c) Emerging therapeutic categories of Herbal Medicinal Products available in market, their composition with rationale for Aphrodisiac, Antistress, anti-diabetics, antihyperlipidemic, immunomodulator, hepatoprotective and kidney disorders (d) Emerging Herbal cosmeceuticals: Anti-Aging, Depigmenting, anti-acne, sunscreen, detoxifying, anti-irritant, nutricosmetics.	8 Hours
II	**Commercial Production and Standardization of botanicals** Significance of AYUSH/ WHO-GMP, GLP and USFDA compliant facility in production of quality herbal products. Commercial production of standardized herbal extracts with clinical relevance: Coleus, Amla, Turmeric, Ashwagandha and Senna. Commercial production and standardization of volatile oils: Eucalyptus oils, Lavender oil and Peppermint oil, Rosemary oil Preparation and standardization of Ayush formulations viz Aristas and Asawas, Ghutika/Habb, Churna/ Shafoof Arq, Sharbat, Tincture and Bhasma.	10 Hours
III	**Modern methods of analysis of Plants and Plant-based products** Basic principles and applications in analysis of botanicals: Spectroscopic methods: UV-Visible spectroscopy, IR Spectroscopy, NMR spectroscopy and Mass spectroscopy, Atomic Absorption Scpectroscopy Chromatographic methods: HPTLC, HPLC, UPLC, GC,	12 Hours
IV	**Isolation, Characterization, Commercial Production and analysis of bioactive phytoconstituents** Isolation, characterization with commercial production, identification and analysis of bioactive phytoconstituents: Artemisinin, Sennosides, Withanolids, Boswellic acid, Atropine, and Lycopene.	08 Hours
V	**International Regulatory Perspectives** (a) Overview of global regulations for herbal products (e.g., World	07 Hours

	Health Organization, United States Food and Drug Administration – Dietary Supplement Health and Education Act, European Medicines Agency, TGA-ARG Therapeutic Goods Administration – Australian Regulatory Guidelines for Complementary Medicines, Natural Health Products (Canada) (b) Harmonization challenges and mutual recognition of traditional medicine (c) Importance of safety, efficacy and pharmacovigilance in herbal product regulation (d) Study of Monographs on herbal drugs and botanicals related to Indian Pharmacopoeia, United States Pharmacopoeia Herbal Medicine and Dietary Supplement, Ayurvedic Pharmacopoeia of India and Unani Pharmacopoeia of India.	

Recommended References (Preferably latest editions)

1. Ayurvedic Pharmacopoeia Committee. *Ayurvedic Pharmacopoeia of India.* Government of India, Ministry of AYUSH.
2. European Medicines Agency. *Herbal Monographs and Regulatory Guidelines.*
3. Indian Drug Manufacturers' Association. *Indian Herbal Pharmacopoeia.*
4. Indian Pharmacopoeia Commission. *Indian Pharmacopoeia.* Government of India.
5. International Council for Harmonisation. *ICH Guidelines on Quality, Safety, Efficacy and Multidisciplinary Topics.*
6. Natural Health Products Directorate. *Regulatory Framework for Natural Health Products.*
7. Unani Pharmacopoeia Committee. *Unani Pharmacopoeia of India.* Government of India, Ministry of AYUSH.
8. United States Pharmacopeial Convention. *United States Pharmacopeia.*
9. World Health Organization. *Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants.*
10. *Drugs and Cosmetics Act and Rules (India).* Government of India.

Course Code	Course Title		Course Type	
BP503T	**Innovation and Startup Ecosystem (Theory)**		Core	
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
2	2	--	--	30
Maximum Marks	SE	ESE		
50	20	30		

COURSE OBJECTIVES:

The objectives of this course are to:

1. Introduce students to the fundamental concepts, principles, and significance of innovation and entrepreneurship in contemporary economic and social contexts.
2. Familiarize students with the structure, components, and key stakeholders of the startup and innovation ecosystem.
3. Provide students with an understanding of the startup lifecycle, including ideation, opportunity analysis, product development, validation, and scaling.
4. Equip students with practical tools and techniques for problem identification, opportunity recognition, business model development, and idea validation.
5. Foster an entrepreneurial mindset by encouraging active participation in innovation-related events, stakeholder interactions, and experiential learning activities.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Explain the fundamental concepts of innovation, entrepreneurship, and the structure and role of the startup ecosystem in economic and social development.
2	Identify and analyze problems, market gaps, and opportunities using ideation tools, market research techniques, and feasibility analysis.
3	Design and validate an innovative solution by developing a minimum viable product (MVP) using lean startup principles and customer feedback.
4	Develop an appropriate business model using the Business Model Canvas, and evaluate legal, intellectual property, team, and funding considerations for startups.
5	Demonstrate effective ecosystem engagement skills by participating in innovation events and presenting a concise startup pitch, incorporating future trends and scaling strategies.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures

I	**Unit I: Introduction to Innovation and Entrepreneurship**
	
	Defining Innovation and Entrepreneurship
	• What is Innovation?
	• Types of Innovation: Product, Process, Business Model, Social
	• What is Entrepreneurship?
	• Characteristics of an Entrepreneur
	
	Invention vs Innovation
	• Distinction between Invention and Innovation
	• Importance of Innovation in the 21st Century
	  ○ Economic growth and job creation
	  ○ Solving societal problems
	• Disruptive technologies and their impact
	
	Case Studies
	• Innovative companies (e.g., Apple, Google, Tesla)
	
	Introduction to the Startup Ecosystem
	• Key components:
	  ○ Entrepreneurs
	  ○ Incubators/Accelerators
	  ○ Mentors
	  ○ Investors
	  ○ Government
	  ○ Academia
	  ○ Support Services
	• Role of each component in fostering innovation
	
	Practical Aspect:
	Participation in **National Innovation Day** and **National Startup Day**
		06 Hours

II	**Unit II: Ideation and Opportunity Identification**
	
	Identifying Problems and Market Gaps
	• Problem-solving approach to entrepreneurship
	• Techniques for problem identification:
	  ○ Observation
	  ○ Empathy mapping
	  ○ User interviews
		06 Hours

	• Market research basics:
	  ○ Understanding customer needs and pain points
	Generating Innovative Ideas
	• Brainstorming techniques:
	  ○ SCAMPER
	  ○ Mind Mapping
	  ○ Design Thinking principles for ideation
	• Lateral thinking and divergent thinking
	• From problem to solution: developing initial concepts
	Opportunity Analysis and Feasibility
	• Market sizing and potential
	• Competitive analysis
	• SWOT analysis for new ventures
	Practical Aspect:
	Participation in **Ideation Challenges or Hackathons** (e.g., *Smart India Hackathon* or IIC internal ideation competitions)	

III	**Unit III: Building a Minimum Viable Product (MVP) and Validation**
	Lean Startup Methodology
	• Introduction to Lean Startup principles
	• Build–Measure–Learn feedback loop
	• Concept of MVP:
	  ○ Importance
	  ○ Scope and objectives
	Designing and Developing an MVP
	• Different types of MVPs
	• Tools and resources for rapid prototyping
	• User experience basics for MVPs
	Validation
	• Customer interviews and feedback collection
	• A/B testing and split testing
	• Pivoting vs Persevering
	Practical Aspect:
	Participation in sessions/workshops on **Prototype, MVP, and Product Development**
		06 Hours

IV	**Unit IV: Business Models and Startup Operations** **Business Model Canvas (BMC)** • Introduction to the 9 building blocks of BMC • Developing a BMC for a new venture • Value Proposition Design **Legal and Financial Aspects for Startups** • Legal structures: ○ Sole Proprietorship	06 Hours

	○ Partnership ○ Private Limited Company • Intellectual Property Rights (IPR): ○ Patents ○ Trademarks ○ Copyrights • Startup funding: ○ Bootstrapping ○ Angel investors ○ Venture capital **Team Building and Mentorship** • Importance of a strong founding team • Roles and responsibilities in a startup • Value of mentors and advisors **Practical Aspect:** Participation in **IPR awareness programs** or **startup funding sessions**	
V	**Unit V: Scaling, Ecosystem Engagement, and Future Trends** **Growth Strategies and Scaling Up** • Marketing and sales for startups • User acquisition and retention • Challenges of scaling and solutions • Exit strategies: ○ Acquisition ○ IPO **Engaging with the Startup Ecosystem** • Networking with investors, mentors, and entrepreneurs • Participation in startup competitions and pitch events • Leveraging incubators and accelerators **Future Trends in Innovation and Entrepreneurship** • Emerging technologies: ○ Artificial Intelligence ○ Blockchain ○ Internet of Things (IoT) ○ Sustainable Technologies • Social entrepreneurship and impact investing • Global startup trends **Practical Aspect:** Participation in **National Innovation Day** and student engagement activities to prepare and deliver a concise pitch for their developed idea, simulating a startup pitch event.	06 Hours
Recommended References (Preferably latest editions)		

1. Eric Ries. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.
2. Thiel, P. and Masters, B. Zero to One: Notes on Startups, or How to Build the Future. Crown Business.
3. Bansal, R. *Stay Hungry Stay Foolish.* Westland.
4. Dalal, M. *Big Billion Startup: The Untold Flipkart Story.* Pan Macmillan India.
5. Ivaturi, V. K. *The Manual for Indian Start-Ups: Tools to Start and Scale-Up Your New Venture.* Notion Press.
6. Mishra, S., Patjoshi, P. K. and Patnaik, S. K. *Innovation and Entrepreneurship.* Pearson India.
7. Sardar, R. and Waghmare, G. *Startup Ecosystem in India: Text and Cases.* Himalaya Publishing House.

Course Code	Course Title		Course Type	
BP504T	**Pharmaceutical Dosage Forms II (Theory)**		Core	
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
2	2	--	--	30
Maximum Marks	SE		ESE	
50	20		30	

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the principles of formulation and development of monophasic liquid dosage forms, including solvent selection and solubility enhancement techniques.
2. Acquire knowledge of biphasic liquid dosage forms, including physicochemical principles, formulation strategies, manufacturing processes, and stability considerations.
3. Develop competence in pressurised dosage forms such as aerosols, metered-dose inhalers, and dry powder inhalers, with emphasis on formulation design, device components, manufacturing, and quality evaluation.
4. Understand the formulation, manufacturing, and evaluation of semisolid dosage forms, with emphasis on drug permeation through the skin and factors affecting topical drug delivery.
5. Gain exposure to advanced drug delivery systems such as nanosuspensions, nanoemulsions, SMEDDS/SNEDDS, xerogels, and emulgels for improved therapeutic performance.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Explain the fundamental principles, classification, formulation requirements, and quality aspects of monophasic and biphasic liquid dosage forms.
2	Formulate, manufacture, and evaluate monophasic and biphasic liquid preparations, including solutions, syrups, elixirs, suspensions, and emulsions, using appropriate excipients and processing techniques.
3	Apply physicochemical principles such as solubility enhancement, Stokes' law, DLVO theory, and emulsification theories to design stable liquid dosage forms and assess their stability and performance.
4	Design and evaluate pressurised and inhalation dosage forms, including aerosols, metered dose inhalers, and dry powder inhalers, by selecting suitable formulation components, devices, and quality control parameters.
5	Formulate, evaluate, and justify the use of semisolid and advanced drug delivery systems—including ointments, creams, gels, suppositories, nanosuspensions, nano-

	emulsions, SMEDDS/SNEDDS, xerogels, and emulgels—for enhanced drug delivery, stability, and patient compliance.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
I	**Monophasic Liquids & Pressurised Dosage Forms** **Foundations:** Need, advantages/limitations; monophasic vs biphasic; solubility-enhancement techniques. **Vehicles & solvents:** Pharmaceutical waters (types; manufacturing & Quality Control of Purified/Distilled); classes of solvents as per toxicity. **Formulation & manufacturing:** Raw-material considerations and additives; processing; Quality Control of solutions/syrups/elixirs; powders for reconstitution as **solutions**. **Measuring, filling & packaging:** Techniques; container–closure integrity; **automation** in liquid manufacturing.	06 Hours
II	**Biphasic Liquids - Suspensions** **Formulation & manufacturing:** Additives; classification of suspending agents; IPQC & Quality Control; instabilities and packaging. **Advances: Nanosuspensions**; dry powder for reconstitution as **suspensions**; **raft- forming** systems.	06 Hours
III	**Biphasic Liquids - Emulsions** **Formulation & manufacturing:** Additives; classification of emulsifying agents; IPQC & Quality Control; instabilities and packaging. **Advances: Nano-emulsions, micro-emulsions, SMEDDS/SNEDDS** (overview, applications).	06 Hours
IV	**Pressurized dosage forms (Aerosols/MDIs)** Concepts; propellant classification/selection; valves & containers; formulation, manufacturing, and Quality Control (leak, spray pattern, delivered dose, particle- size/aerodynamic performance). **Dry Powder Inhalers:** valves & containers; formulation, manufacturing, and Quality Control	06 Hours
V	**Semisolid Dosage Form** **Theory of Semisolid Dosage Forms:** Definition & Purpose, Drug Permeation Pathways through skin ,Factors affecting Permeation, Permeation enhancers: Physical and Chemical. **Types of semisolid dosage form:** • **Ointments:** Base Selection, Formulation , Manufacturing and Evaluation	06 Hours

	• **Creams:** Formulation, Manufacturing and Evaluation • **Gels/Jellies:** Formulation, Manufacturing and Evaluation. • **Pastes:** Formulation, Manufacturing and Evaluation • **Suppositories and Pessaries:** Formulation, Manufacturing and Evaluation **Advances: Xerogels, emulgels** (overview, applications).	

Recommended References (Preferably latest editions)

1. Aulton, M. E. *Aulton's Pharmaceutics: The Science of Dosage Form Design.* Elsevier.
2. Gibson, M. *Pharmaceutical Preformulation and Formulation.* CRC Press.
3. Lachman, L., Lieberman, H. A. and Kanig, J. L. *The Theory and Practice of Industrial Pharmacy.* CBS Publishers & Distributors.
4. Robinson, J. R. and Lee, V. H. L. *Controlled Drug Delivery: Fundamentals and Applications.* CRC Press.
5. Troy, D. B. and Beringer, P. *Remington: The Science and Practice of Pharmacy.* Pharmaceutical Press.
6. *Indian Pharmacopoeia.* Indian Pharmacopoeia Commission.

Course Code	Course Title		Course Type	
BP505T	**Pharmaceutical Quality Assurance (Theory)**		Core	
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
3	3	--	--	45
Maximum Marks	SE		ESE	
75	30		45	

COURSE OBJECTIVES:

The objectives of this course are to:

1. Introduce the concepts and systems of pharmaceutical quality management
2. Provide an overview of regulatory frameworks governing pharmaceutical quality.
3. Familiarize students with organizational, infrastructural, and operational requirements of pharmaceutical manufacturing and quality control.
4. Explain quality control testing of pharmaceutical products
5. Understand the documentation, validation, calibration, and data integrity essential for regulatory compliance.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Explain the concepts of QA, QC, GMP, GLP and modern Quality Management Systems.
2	Apply TQM, QbD, and ICH guidelines to ensure consistent pharmaceutical quality.
3	Understand requirements related to personnel, premises, equipment, materials, and documentation.
4	Describe quality control testing of pharmaceutical products.
5	Explain calibration, qualification, and analytical method validation as per regulatory guidelines.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
I	**Quality Assurance and Quality Management Systems** 1. Quality Assurance and Quality Management concepts: Definition and concepts of Quality Control, Quality Assurance, and GMP 2. Total Quality Management (TQM): Definition, elements, and philosophies 3. ICH Guidelines: Purpose, process of harmonization, overview of QSEM with special emphasis on Q-series guidelines	10 hours

	4. Quality by Design (QbD): Definition, overview, elements of QbD program, and tools 5. ISO 9000 and ISO 14000: Overview, benefits, elements, and steps for registration 6. NABL Accreditation: Principles and procedures	
II	**Organization, Personnel, Premises, and Materials Management** 1. Organization and Personnel: Responsibilities, training, hygiene, and personal records 2. Premises: Design, construction, plant layout, maintenance, sanitation, environmental control, utilities, and control of contamination 3. Equipment and Raw Materials: Equipment selection, User Requirement Specifications (URS), handling and maintenance of raw materials 4. Warehousing: Good warehousing practices and materials management	10 hours
III	**Quality Control and Good Laboratory Practices** 1. Quality Control Tests for Formulations: In-process and finished product quality control tests for tablets, capsules, ointments, creams, ophthalmic and parenteral preparations 2. Quality Control of Raw Materials and Packaging Materials: Tests for raw materials, containers, rubber closures, and secondary packing materials 3. Good Laboratory Practices (GLP): General provisions, organization and personnel, facilities and equipment, ALCOA principles, reference standards, testing facility operations, records and reports, and disqualification of testing facilities	10 hours
IV	**Documentation, Complaints, and Product Recall** 1. Documentation in the Pharmaceutical Industry: Batch Formula Record, Master Formula Record, Drug Master File, SOPs, quality audits, preparation, handling, archival, and distribution of records 2. Complaints and Product Recall: Handling of complaints, evaluation of complaints, returned goods, recalls, and waste disposal	08 hours
V	**Calibration and Validation** 1. Calibration and Validation: Introduction, definitions, importance, and general principles Calibration of weights and measures, pH meter Qualification of UV-Visible spectrophotometer, electronic balance, IR spectrophotometer, and HPLC 2. Analytical Method Validation: General principles of analytical method validation as per ICH Q2 guidelines	07 hours
Recommended References ***(Preferably latest editions)*** 1. Godfrey, A. B. and Juran, J. M. Juran's Quality Handbook. McGraw-Hill Education. 2. Organisation of Pharmaceutical Producers of India. Quality Assurance Guide. OPPI.		

3. Weinberg, S. Good Laboratory Practice Regulations. Marcel Dekker.
4. World Health Organization. Quality Assurance of Pharmaceuticals: A Compendium of Guidelines and Related Materials. World Health Organization.

Course Code	Course Title		Course Type	
BP506T	**Systemic Pharmacology II (Theory)**		Core	
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
3	3	--	--	45
Maximum Marks	SE		ESE	
75	30		45	

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the neurohumoral transmission in the central nervous system and the role of neurotransmitters and their modulators in CNS disorders.
2. Learn the pharmacology of drugs used in pathological conditions of CNS, GIT, and endocrine system.
3. Familiarize learners with concepts of drug abuse, addiction, dependence, tolerance, and their management.
4. Impart comprehensive knowledge of chemotherapeutic agents including anticancer drugs.
5. Introduce the principles of rational use of chemotherapeutic agents.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Identify the role of neurotransmitters in CNS diseases and explain pharmacology of drugs acting on central neurotransmission.
2	Apply principles of chemotherapy to explain mechanisms and uses of chemotherapeutic agents.
3	Recall pharmacology of hormones and drugs used in endocrine disorders.
4	Describe mechanisms and therapeutic uses of drugs acting on the gastrointestinal tract.
5	Recognize issues related to drug abuse, addiction, and dependence and their management.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
I	**Pharmacology of Drugs Acting on Central Nervous System** Neurohumoral transmission in the CNS; physiological roles of GABA, glutamate, glycine, serotonin, and dopamine. a. General anesthetics, pre-anaesthetic medications, and local anaesthetic agents b. Sedative–hypnotics c. Alcohol and disulfiram d. Opioids, opiate analgesics, and antagonists e. Drugs used in epilepsy f. Drugs used in Parkinson's and Alzheimer's diseases	10 hours
II	**Pharmacology of Drugs Used in Psychiatry** a. Antipsychotics, antidepressants, anti-anxiety drugs, mood stabilizers, CNS stimulants, and hallucinogens b. Substance abuse, drug addiction, and general principles of de-addiction	07 hours
III	**Chemotherapy** **i) Introduction** a. Definitions of chemotherapy, chemotherapeutic index, antibiotics, and antimicrobial agents b. Concept of selective targeting in chemotherapy c. Classification of antimicrobial agents based on mechanism of action d. Concept of superinfection, chemoprophylaxis, and combined use of antibiotics e. Antimicrobial resistance: causes, mechanisms, and preventive measures **ii) Antimicrobial Agents** Classification, mechanism of action, adverse drug reactions, and therapeutic uses of: • Sulphonamides and cotrimoxazole • Fluoroquinolones • Penicillins and cephalosporins • Macrolides and tetracyclines • Linezolid • Carbapenems and monobactams • Chloramphenicol and aminoglycosides **iii) Chemotherapy of Diseases** Drugs used in the treatment of: • Fungal infections • Viral infections	14 hours

	• Helminthiasis • Urinary tract infections • Tuberculosis • Leprosy • Malaria • Amoebiasis • Neoplastic diseases	
IV	**Pharmacology of Drugs Acting on Endocrine System** a. Introduction to basic concepts of endocrinology b. Thyroid and antithyroid agents c. Parathormone, calcitonin, and vitamin D d. Insulin and oral hypoglycaemic agents e. ACTH and corticosteroids f. Oral contraceptives g. Drugs acting on the uterus h. PCOD	10 hours
V	**Drugs Acting on Gastrointestinal Tract** a. Drugs used in peptic ulcer b. Drugs used for constipation and diarrhoea c. Emetics and anti-emetics d. Digestants, carminatives, appetizers, and anorectics – definitions and examples	04 hours

Recommended References *(Preferably latest editions):*

1. Brunton, L., Hilal-Dandan, R. and Knollmann, B. *Goodman and Gilman's The Pharmacological Basis of Therapeutics.* McGraw-Hill Education.
2. Craig, C. R. and Stitzel, R. E. *Modern Pharmacology with Clinical Applications.* Lippincott Williams & Wilkins.
3. DiPiro, J. T., Talbert, R. L., Yee, G. C. and Matzke, G. R. *Pharmacotherapy: A Pathophysiologic Approach.* McGraw-Hill Education.
4. Katzung, B. G. and Trevor, A. J. *Basic and Clinical Pharmacology.* McGraw-Hill Education.
5. Rang, H. P., Dale, M. M., Ritter, J. M., Flower, R. J. and Henderson, G. *Rang and Dale's Pharmacology.* Elsevier.
6. Tripathi, K. D. *Essentials of Medical Pharmacology.* Jaypee Brothers Medical Publishers.

Course Code	Course Title		Course Type	
BP507P	**Biomedicinal Chemistry (Practical)**		Core	
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
2	--	--	4	60
Maximum Marks	SE		ESE	
50	20		30	

COURSE OBJECTIVES:

The objectives of this course are to:

1. Comprehend the fundamental principles of drug synthesis and apply them to the preparation of selected drug molecules and intermediates.
2. Develop practical skills in performing laboratory techniques for the synthesis of organic compounds, including the use of microwave irradiation.
3. Understand and apply the principles of drug assay to quantitatively analyze the purity and concentration of given drug samples.
4. Learn and utilize computational tools to predict physicochemical and ADME properties of drug molecules.
5. Apply molecular docking techniques to predict drug-target interactions.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Successfully synthesize specified drug molecules and intermediates in the laboratory.
2	Demonstrate competence in using microwave irradiation for efficient chemical synthesis.
3	Accurately perform drug assays to determine the concentration and purity of drug samples.
4	Analyze physicochemical and ADME properties of drug candidates using computational tools.
5	Conduct and interpret molecular docking studies to understand drug-receptor binding.

Detailed Syllabus:

List of practical
1. Preparation of Drugs / Intermediates **(Any 4)** • 7-Hydroxy-4-methyl coumarin • Thiobarbituric acid • 2,3-Diphenylquinoxaline • Sulphanilamide • Triphenyl imidazole • Perform synthesis of intermediate/drug using microwave irradiation or green chemistry techniques. **2.** Assay of Drugs **(Any 4)** • Sulpha drugs • Metronidazole • Isoniazid • Phenobarbitone • Benzyl penicillin • Chloroquine **3.** Drug Design & Computational Tools **(Any 4)** • Calculate physicochemical and ADME properties using Swiss ADME (e.g. logP, molecular weight, H-bond donors/acceptors) • Perform basic molecular docking studies using any of open-source academic tools.
Recommended References *(Preferably latest editions):* 1. Abraham, D. J. and Griffin, J. L. *Burger's Medicinal Chemistry and Drug Discovery.* Wiley. 2. Finar, I. L. *Organic Chemistry.* Pearson Education. 3. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry.* Pearson Education. 4. Lednicer, D. *The Organic Chemistry of Drug Synthesis.* Wiley. 5. Patrick, G. L. *An Introduction to Medicinal Chemistry.* Oxford University Press. 6. Remington. *The Science and Practice of Pharmacy.* Pharmaceutical Press. 7. Williams, D. A., Lemke, T. L. and Roche, V. F. *Foye's Principles of Medicinal Chemistry.* Lippincott Williams & Wilkins. 8. Wilson, C. O., Beale, J. M. and Block, J. H. *Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry.* Lippincott Williams & Wilkins. 9. *Indian Pharmacopoeia.* Indian Pharmacopoeia Commission. 10. Brown, N. Artificial Intelligence in Drug Discovery. Cambridge: Royal Society of Chemistry.

Course Code	Course Title		Course Type	
BP508P	**Industrial Pharmacognosy (Practical)**		Core	
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
1	--	--	3	45
Maximum Marks	SE		ESE	
50	20		30	

COURSE OBJECTIVES:

The objectives of this course are to:

1. Apply knowledge of chromatographic and spectroscopic techniques for the separation, isolation, and analysis of phytoconstituents.
2. Learn isolation and characterization of major secondary metabolites and volatile oil constituents using standard laboratory methods.
3. Perform chemoprofiling, purification, and quantitative estimation of herbal and Ayurvedic formulations.
4. Prepare and document herbal drug monographs and traditional formulations as per IP, API, and IHP guidelines.
5. Integrate experiential learning and community-based studies for understanding the use, quality, and awareness of traditional medicines.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Apply chromatographic techniques for isolation and analysis of phytoconstituents
2	Isolate and identify key compounds from medicinal plants phytoconstituents
3	Standardize Ayurvedic formulations and determine alcohol content.
4	Prepare herbal drug monograph and assess traditional formulations.
5	Evaluate and analyze marketed and community-used traditional formulations through case studies and experiential learning.

Detailed Syllabus:

List of practical ***(Minimum 12 experiments must be performed)***
1. To perform column chromatography for isolation of phytochemicals. 2. Preparative TLC of curcuminoids. 3. Isolation and identification of Piperine. 4. Isolation and identification of Sennoside. 5. Isolation and identification of Withanolide. 6. Isolation and identification of Lycopene. 7. Acid – base purification process for the separation of alkaloids. 8. Chemoprofiling of purified alkaloidal fraction. 9. Separation of amino acid by paper chromatography. 10. TLC/HPTLC/HPLC of herbal extracts/ botanicals. 11. Isolation and determination of total aldehyde content in volatile oil. 12. Preparation of monographs on herbal drugs wrt IP, API, IHP. 13. Determination of the alcohol content of Asava and Arista. 14. Standardization of any two Ayurvedic formulations using UV-spectroscopy. 15. Preparation and evaluation of Ayurvedic churna. 16. Experiential learning-based experiments focused on the preparation and practical applications of folkloric or region-specific traditional formulations within the community. 17. Case studies analyzing community awareness and usage patterns of various traditional formulations.
Recommended References *(Preferably latest editions):* 1. Mukherjee, P. K. *Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals.* Business Horizons. 2. Sinha, D., Mukherjee, S. and Chowdhury, S. *Methods of Extraction of Phytochemicals.* IGI Global. 3. Zhang, J., Wen, C., Zhang, H., Duan, Y. and Ma, H. *Extraction of Bioactive Compounds with Subcritical Water.* Elsevier.

Course Code	Course Title			Course Type
BP509P	**Pharmaceutical Dosage Forms II (Practical)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
1	--	--	3	45
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand various solubility enhancement techniques.
2. Provide hands-on experience in manufacturing processes and evaluation of monophasic and biphasic liquid dosage forms.
3. Provide hands-on experience in manufacturing processes and evaluation of semisolid dosage forms.
4. Learn manufacturing processes and evaluation of pressurised dosage forms.
5. Understand the effects of formulation parameters on the performance of biphasic and semisolid dosage forms.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Apply the fundamentals of solubility enhancement during dosage form development.
2	Explain manufacturing processes of monophasic and biphasic liquid dosage forms.
3	Demonstrate manufacturing processes of semisolid dosage forms.
4	Provide insights into evaluation of dosage forms.
5	Compare the effects of formulation parameters on the performance of biphasic and semisolid dosage forms.

Detailed Syllabus:

List of practicals ***(Minimum 12 experiments must be performed)***
1. To enhance the solubility of a BCS Class II drug by solid dispersion technique. 2. To enhance the solubility of a BCS Class II drug by cyclodextrin complexation. 3. Preparation and evaluation of medicated syrups using simple and artificial syrup bases. 4. Preparation and evaluation of different types of pharmaceutical emulsions. 5. Preparation and evaluation of an emulsion with a small-dose oily active (e.g., calciferol). 6. Preparation and evaluation of an oral suspension. 7. To study the effect of different suspending agents/concentrations on sedimentation volume. 8. Preparation and evaluation of a dry powder for reconstitution as a suspension. 9. Preparation and evaluation of pharmaceutical creams. 10. Preparation and evaluation of pharmaceutical gels. 11. To study the effect of different gelling agents/concentrations on viscosity of gels. 12. Preparation and evaluation of medicated suppositories. 13. Preparation and evaluation of medicated pessaries. 14. Preparation and evaluation of in-situ gels. 15. Preparation and evaluation of emulgels.
Recommended References *(Preferably latest editions):* 1. Aulton, M. E. *Aulton's Pharmaceutics: The Science of Dosage Form Design.* Elsevier. 2. Gibson, M. *Pharmaceutical Preformulation and Formulation.* CRC Press. 3. Lachman, L., Lieberman, H. A. and Kanig, J. L. *The Theory and Practice of Industrial Pharmacy.* CBS Publishers & Distributors. 4. Robinson, J. R. and Lee, V. H. L. *Controlled Drug Delivery: Fundamentals and Applications.* CRC Press. 5. Troy, D. B. and Beringer, P. *Remington: The Science and Practice of Pharmacy.* Pharmaceutical Press. 6. *Indian Pharmacopoeia.* Indian Pharmacopoeia Commission.

Course Code	Course Title			Course Type
BP510P	**SYSTEMIC PHARMACOLOGY II (Practical)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours.
	L	T	P	
2	--	--	4	60
Maximum Marks	SE		ESE	
50	20		30	

COURSE OBJECTIVES:

The objectives of this course are to:

1. Provide understanding of the theoretical and practical aspects of different pharmacological experiments using virtual simulations and video demonstrations.
2. Develop skills to assess drug effects on various systems such as cardiovascular, respiratory, skeletal muscle, and gastrointestinal using simulation models.
3. Familiarize the learners with experimental methodologies such as Langendorff's heart preparation, spasmogenic and spasmolytic effects, and PA2 value determination using Schild plot.
4. Provide knowledge of the modern techniques for drug evaluation, such as intraocular pressure measurement, nitric oxide estimation, neutrophil function tests and spirometry.
5. Explore clinical pharmacology aspects through case studies on drug interactions, management of cardiovascular and respiratory diseases, and plasma volume expanders.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Explain the pharmacological principles and mechanisms of drug action involved in analgesic, antiepileptic, antidepressant, antipsychotic, antianxiety, and antiulcer drugs using interactive computer-based experimental models.
2	Apply experimental and simulation-based methods to evaluate drug activity using models such as Eddie's hot plate, MES-induced seizures, tail suspension test, elevated plus maze, actophotometer, Morris water maze, and ulcer models.
3	Analyse and interpret experimental pharmacological data, including bioassay results, dose-response relationships, and estimation of agonist/antagonist concentrations using 3-point/4-point bioassay, matching/bracketing methods, and hypothetical simulation datasets.
4	Demonstrate advanced biomedical and laboratory techniques, including cell culture methods, PCR for mRNA estimation, electrophoresis of DNA/proteins, and antibacterial sensitivity testing, relevant to pharmaceutical and biomedical research.
5	Utilize bioinformatics tools, open-source pharmacological databases, and network pharmacology software to predict drug targets, analyse ADME/toxicity profiles, and construct pharmacological networks.

Detailed Syllabus:

List of practical

(Minimum 12 experiments must be performed)

1. Evaluation of analgesic activity of centrally and peripherally acting analgesics using Eddie's hot plate, tail-flick, tail immersion, and acetic acid-induced writhing methods through interactive computer simulation.
2. Evaluation of antiepileptic activity using maximal electroconvulsive shock (MES)-induced seizures through interactive computer simulation.
3. Demonstration of the antiepileptic activity using pentylenetetrazol-induced seizures through interactive computer simulation.
4. Evaluation of antidepressant activity of drugs using the tail suspension test through interactive computer simulation.
5. Demonstration and study of locomotor activity using actophotometer through interactive computer simulation.
6. Evaluation of antianxiety activity using the elevated plus maze or zero maze model through interactive computer simulation.
7. Evaluation of antipsychotic activity of drugs using inhibition of conditioned response on Cook's pole climbing apparatus through interactive computer simulation.
8. Study of the effect of drugs on learning and memory using the Morris water maze test through interactive computer simulation.
9. Study of antiulcer activity using indomethacin-induced or pylorus ligation-induced ulcer models.
10. Estimation of the concentration of oxytocin on isolated rat uterus preparation using a suitable method through interactive computer-based simulation.
11. Estimation of drug concentration by 3-point or 4-point bioassay through interactive computer simulation.
12. Bioassay of histamine using matching, bracketing, or interpolation methods on suitable isolated tissue preparation with the help of interactive computer simulation.
13. Study of cell culture techniques, including types of cell culture, laboratory instruments/equipment, culture media, and growth of cell cultures in laboratory facilities.
14. Study of antibacterial sensitivity testing of urine culture using techniques such as the disc diffusion method (theoretical details/case studies).

15. Demonstration using databases and software packages for predicting drug activity, ADME properties, and toxicity.

16. Study of electrophoresis of protein and DNA samples and gel visualization techniques.

17. Construction of pharmacological networks using predicted drug targets and disease genes with activity prediction databases, disease gene databases, and suitable software.

Recommended References *(Preferably latest editions):*

1. Ghosh, M. N. *Fundamentals of Experimental Pharmacology.* Hilton & Company.
2. Goyal, R. K. *Practical Pharmacology.* B. S. Shah Prakashan.
3. Kulkarni, S. K. *Handbook of Experimental Pharmacology.* Vallabh Prakashan.