DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY,
UTTAR PRADESH, LUCKNOW

Syllabus

For

M.Pharm. (Quality Assurance)

(Effective from the Session: 2016-17)

Course Structure and Evaluation Scheme for M. Pharm. Courses (All Subjects/ Specialization) (Effective from Session 2016-17)

QUALITY ASSURANCE

Semester-I

S.N.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	*MPA101*	Modern Pharmaceutical Analytical Techniques	3	0	0	3	20	10	70	--	--	100
2	*MQA101/ MQA203*	Quality Management System/ Audits & Regulatory Compliance	3	0	0	3	20	10	70	--	--	100
3	*MQA102/ MQA204*	Quality Control & Quality Assurance/ Pharmaceutical Manufacturing Technology	3	0	0	3	20	10	70	--	--	100
4	*MQA103*	Product Development & Technology Transfer	3	0	0	3	20	10	70	--	--	100
5	*RPM101*	Research Process & Methodology	3	0	0	3	20	10	70	--	--	100
6	*MPA105*	Modern Pharmaceutical Analytical Techniques Practical	-	-	2	1	--	--	--	20	30	50
7	*MQA104*	Pharmaceutical Quality Assurance Practical-I	-	-	3	2	--	--	--	20	30	50
Total						**18**						**600**

Semester-II

S.N.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	*MQA201*	Hazards & Safety Management	3	0	0	3	20	10	70	--	--	100
2	*MQA202*	Pharmaceutical Validation	3	0	0	3	20	10	70	--	--	100
3	*MQA203/ MQA101*	Audits & Regulatory Compliance/ Quality Management System	3	0	0	3	20	10	70	--	--	100
4	*MQA204/ MQA102*	Pharmaceutical Manufacturing Technology/ Quality Control & Quality Assurance	3	0	0	3	20	10	70	--	--	100
5	*MQA205*	Biological Standardization & Quality Control	3	0	0	3	20	10	70	--	--	100
6	*MQA206*	Pharmaceutical Quality Assurance Practical-II	-	-	2	1	--	--	--	20	30	50
7	*MQA207*	Seminar-I (Synopsis)	-	-	3	2	--	--	--	50	--	50
Total						**18**						**600**

Semester-III

S.N.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	*MQA301*	Seminar-II	0	0	6	3	--	--	--	100	--	100
2	*MQA302*	Dissertation (Research Project Audit)	0	0	30	15	--	--	--	200	300	500
Total						**18**						**600**

Semester-IV

S.N.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	*MQA401*	Dissertation (Final)	0	0	36	18	--	--	--	200	400	600
Total						**18**						**600**

M. Pharm. (Quality Assurance)
First Semester

MODERN PHARMACEUTICAL ANALYTICAL TECHNIQUES (*MPA101*)

Unit-I

UV-Visible spectroscopy: Introduction, theory and laws associated with UV-visible spectroscopy, chromophores, auxochromes and their interaction with UV-Vis radiations, choice of solvents and solvent effect. Woodward- Fieser rule and applications of UV-visible spectroscopy.

IR Spectroscopy: Theory, modes of molecular vibrations, factors affecting vibrational frequencies and applications of IR spectroscopy. FT-IR. Interpretation of IR spectra of organic compounds.

Unit-II

Mass spectrometry: Different ionization methods (EI, CI, FAB, ESI, MALDI), analyzers of quadrupole and time of flight. Fragmentation patterns and its rules, relative abundance of ions, molecular ion peak, meta stable ions, isotopic peaks, Mc-Lafferty rearrangement, ring rule. Applications of mass spectrometry.

Flame emission spectroscopy and atomic absorption spectroscopy*:* Principle, interferences and applications of flame emission spectroscopy and atomic absorption spectroscopy.

Unit-III

NMR Spectroscopy: Principle, chemical shift, factors influencing chemical shift, spin-spin coupling, coupling constant, solvent requirement in NMR, NMR active compounds, free induction decay, relaxation process and NMR signals in various compounds. Applications of NMR spectroscopy.

Unit-IV

Chromatography: Principle, chromatographic parameters, factors affecting and applications of: Thin Layer chromatography, column chromatography, gas chromatography, affinity chromatography, ion exchange chromatography, size exclusion chromatography, high performance liquid chromatography, high performance thin layer chromatography.

Unit-V

Miscellaneous techniques:

Thermal methods of analysis: Introduction, principle, instrumentation and application of TGA, DTA and DSC.

Electron microscopy: Principle, instrumentation and applications of scanning electron microscopy (SEM), transmission electron, microscopy (TEM).

Radioimmuno assay: ELISA.

SUGGESTED BOOKS:

1. Pharmacopoeia of India, Ministry of Health, Govt. of India.
2. Skoog D.A., Holler F.J., Crouch S. R., Instrumental Analysis, Indian Edition, Brooks/Cole, Boston.
3. Willard H.H., Merrit L.L., Dean J.A., Settle P.A., Instrumental Methods of analysis, CBS Publishers and Distributors New Delhi.
4. Kemp W., Organic Spectroscopy, Palgrave, New York.
5. Becket A.H. and Stenlake J.B., Practical Pharmaceutical Chemistry Vol. I and II, The Athlone Press of the University of London.
6. Pavia D.L., Lampman G.M. and Kriz G.S., Introduction to Spectroscopy, Harcourt College Publishers, Philadelphia.
7. Kalsi P.S., Spectroscopy of Organic Compounds, New Age International Publishers, New Delhi.
8. Florey K., Analytical Profile of Drug Substance (All volume), Academic Press, Elsevier, Massachusetts.

9. Chatten L.G., A Text Book of Pharmaceutical Chemistry, Vol. I and II, Marcel Dekker, New York.
10. Silverstein R.M., Spectrometric Identification of Organic compounds, John Wiley & Sons, New Jersey.
11. Obonson J.W.R., Undergraduate Instrumental Analysis, Marcel Dekker Inc, New York.
12. Parikh V.H., Absorption Spectroscopy of Organic Molecules, Addison-Wesley Publishing Co., London.
13. Stahl E., Thin Layer Chromatography: A Laboratory Handbook, Springer, Berlin.

QUALITY MANAGEMENT SYSTEMS (*MQA101/MQA203*)

Unit-I

Introduction to quality: Definition, evolution and dimensions of quality. Quality as a strategic decision: Meaning of strategy and strategic quality management, mission and vision statements, quality policy, quality objectives, strategic planning and implementation, McKinsey 7s model, competitive analysis.
Customer focus: Introduction, classification, focus and requirements of customer. Customer perception of quality, factors affecting customer perception, customer satisfaction handling customer complaints, understanding customer behavior, concept of internal and external customers.

Unit-II

Cost of quality: Introduction, categories and models are cost of quality, categories of cost of quality, models of cost of quality, optimizing costs, preventing cost of quality.
Pharmaceutical quality management: Basics of quality management, principles of six sigma. Pharmaceutical quality management-ICH Q10, knowledge management, quality metrics, operational excellence and quality management review. WHO-GMP requirements.

Unit-III

Six system inspection model: Quality management system, production system, facility and equipment system, laboratory control system, materials system, packaging and labeling system. Concept of self inspection.
Quality systems: Change management/ change control, deviations, out of specifications (OOS), out of trend (OOT). Complaints: Evaluation and handling, investigation and determination of root cause, corrective and preventive actions (CAPA), returns and recalls, vendor qualification, annual product reviews, batch review and batch release.

Unit-IV

Drug stability: Design, process development and stability testing drug substances and drug products as ICH Q8 guidelines.
Quality risk management: Introduction, risk assessment, risk control, risk review, risk management tools, HACCP, risk ranking and filtering according to ICH Q9 guidelines.

Unit-V

Statistical process control (SPC): Definition and importance of SPC, quality measurement in manufacturing, statistical control charts - concepts and general aspects, advantages of statistical control, process capability, estimating inherent or potential capability from a control chart analysis.

SUGGESTED BOOKS:

1. Antony J., and Preece D., Understanding, Managing and Implementing Quality: Frameworks, Techniques and Cases, Routledge, Taylor and Francis Group, New York.
2. Lawler E.E., Mohrman S.A., Benson G., Organizing for High Performance: Employee Involvement, TQM, Reengineering, and Knowledge Management in the Fortune 1000, Jossey-Bass, New Jersey.

3. Sonn J.W.F., Corporate Culture and the Quality Organization Quorum Books, Westport, Connecticut, London.
4. Avery C., and Zabel D., The Quality Management Sourcebook: An International Guide to Materials and Resources, Routledge, Taylor and Francis Group, New York.
5. Tague N.R., The Quality Toolbox, ASQ Publications, Milwaukee WI 53203.
6. Juran J. M., and Feo J. A. D., Juran's Quality Handbook, ASQ Publications, Milwaukee WI 53203.
7. Okes D., Root Cause Analysis, The Core of Problem Solving and Corrective Action, ASQ Publications, Milwaukee WI 53203.

QUALITY CONTROL AND QUALITY ASSURANCE (*MQA102/MQA204*)

Unit-I

Introduction: Concept, evolution and scopes of quality control and quality assurance,
Good laboratory practice: Introduction, scope and overview of ICH guidelines QSEM, with special emphasis on Q-series guidelines, quality assurance unit, protocol for conduct of non clinical testing, control on animal house, report preparation and documentation. CPCSEA guidelines.

Unit-II

cGMP guidelines according to schedule M, USFDA (inclusive of CDER and CBER) and WHO covering: Organization and personnel responsibilities, training, hygiene and personal records, drug industry location, design, construction and plant lay out, maintenance, sanitation, environmental control, utilities and maintenance of sterile areas, control of contamination and good warehousing practice.

Unit-III

Analysis of raw materials, finished products, packaging materials, in process quality control (IPQC), developing specification (ICH Q6 and Q3), purchase specifications and maintenance of stores for raw materials. In process quality control and finished products quality control for following dosage forms in pharma industry according to Indian and US Pharmacoepia: Tablets, capsules, ointments, suppositories, creams, parenterals, ophthalmic and surgical products.

Unit-IV

Documentation in pharmaceutical industry: Three tier documentation, policy, procedures and work instructions, and records (Formats), basic principles- How to maintain, retention and retrieval etc. Standard operating procedures (How to write), master batch record, batch manufacturing record, quality audit plan and reports. Specification and test procedures, protocols and reports. Distribution records and electronic data handling. Concepts of controlled and uncontrolled documents. Submission documents for regulators DMFs, as common technical document and electronic common technical documentation (CTD, eCTD). Concept of regulated and non regulated markets.

Unit-IV

Manufacturing operations and controls: Sanitation of manufacturing premises, mix- ups and cross contamination, processing of intermediates and bulk products, packaging operations, release of finished product, process deviations, charge-in of components, time limitations on production, drug product inspection, expiry date calculation, calculation of yields, production record review, change control, aseptic process control, packaging, reprocessing, salvaging, handling of waste and scrap disposal.

SUGGESTED BOOKS:

1. Quality Assurance Guide by Organization of Pharmaceutical Procedures of India, Vol. I and II, Mumbai.
2. Weinberg S., Good Laboratory Practice Regulations, Vol. 69, Marcel Dekker Series.
3. Quality Assurance of Pharmaceuticals- A Compendium of Guidelines and Related materials, Vol. I and II, WHO Publications.

4. Sharma P.P., How to Practice GMP's, Vandana Publications, Agra.
5. The International Pharmacopoeia, Vol. I-V, General Methods of Analysis and Quality Specification for Pharmaceutical Substances, Excipient and Dosage Forms, WHO, Geneva.
6. Hirsch A.F., Good laboratory Practice Regulations, Vol. 38, Marcel Dekker Series, New York.
7. ICH guidelines.
8. ISO 9000 and Total Quality Management.
9. Deshpande S.W. and Gandhi N., The Drugs and Cosmetics Act 1940, Susmit Publishers, Mumbai.
10. Shah D.H., QA Manual, Business Horizons, New Delhi.
11. Willig S. H., Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control, Vol. 52, Marcel Dekker Series, New York.
12. Steinborn L., GMP/ISO Quality Audit Manual for Healthcare Manufacturers and Their Suppliers, Vol. 1 (With Checklists and Software Package). Taylor and Francis, New York.
13. Sarker D.K., Quality Systems and Controls for Pharmaceuticals. John Wiley and Sons, New York.
14. Bhusari K.P., Shivhare U.D., Goupale D.C., Pharmaceutical Quality Assurance and Management, PharmaMed Press, Hyderabad.

PRODUCT DEVELOPMENT AND TECHNOLOGY TRANSFER (*MQA103*)

Unit-I

Principles of drug discovery and development: Introduction, clinical research process. Development and informational content for investigational new drugs application (IND), new drug application (NDA), abbreviated new drug application (ANDA), supplemental new drug application (SNDA), scale up post approval changes (SUPAC) and bulk active chemical post approval changes (BACPAC), post marketing surveillance, product registration guidelines- CDSCO, USFDA.

Unit-II

Pre-formulation studies: Introduction/ concept, organoleptic properties, purity, impurity profiles, particle size, shape and surface area. Solubility, methods to improve solubility of drugs: Surfactants and its importance, co-solvency. Techniques for the study of crystal properties and polymorphism. Pre-formulation protocol, stability testing during product development.

Unit-III

Pilot plant scale up: Concept, significance, design, layout of pilot plant scale up study, operations, large scale manufacturing techniques (formula, equipment, process, stability and quality control) of solids, liquids and semisolid. New era of drug products: Opportunities and challenges.

Unit-IV

Pharmaceutical packaging: Pharmaceutical dosage form and their packaging requirements, pharmaceutical packaging materials, medical device packaging, enteral packaging, aseptic packaging systems, container closure systems, issues facing modern drug packaging, selection and evaluation of pharmaceutical packaging materials. Quality control test: containers, closures and secondary packing materials.

Unit-V

Technology transfer: Development of technology by R and D, technology transfer from R and D to production, optimization and production, qualitative and quantitative technology models.
Documentation in technology transfer: Development report, technology transfer plan and exhibit.

SUGGESTED BOOKS:

1. Smith C.G., and O'Donnell J., The Process of New Drug Discovery and Development. CRC Press, Florida.
2. Khar R. K., Vyas S. P., Ahmad F. J., Jain G. K., Lachman/Lieberman's The Theory and Practice of Industrial Pharmacy, CBS Publishers and Distributors Pvt. Ltd., New Delhi.
3. Willig S.H., Tuckerman M.M., Hitchings IV W.S., Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control, Bhalani Publishing House, Mumbai.
4. Lachman L., Lieberman H.A., Schwartz J.B., Tablets, Vol. I-III, CBS Publishers and Distributors, New Delhi.
5. Gibaldi M., Text book of Biopharmaceutics and Clinical Pharmacokinetics, Lea & Febiger, Philadelphia.
6. Patravale V.B., Disouza J.I., Rustomjee M.T., Pharmaceutical Product Development Insights into Pharmaceutical Processes, Management and Regulatory Affairs, CRC Press, Florida.
7. Abdou H.M., Dissolution, Bioavailability and Bio-Equivalence, Mack Publishing Company, New Jersey.
8. Gennaro A.R., Remington: The Science and Practice of Pharmacy, Lippincott Williams and Wilkins, Philadelphia.
9. Savant D.A., The Pharmaceutical Sciences Pharma Pathway Industrial and Applied Pharmacy, Nirali Prakashan, Pune.
10. Dean D.A., Evans E.R., Hall I.H., Pharmaceutical Packaging Technology, Taylor and Francis, New York.

RESEARCH PROCESS & METHODOLOGY (*RPM101*)

Unit-I

Fundamentals of research: Meaning, objective and importance of research methodology, types of research (basic, applied and patent oriented), defining research problem, research design including various methods, research process and steps involved. Literature survey and documentation.

Unit-II

Data collection, analysis and hypothesis testing: Classification of data, methods of data collection, sample size, sampling procedure and methods. Data processing and graphical representation of data. Statistical inference and hypothesis: Types of hypothesis (experimental and non-experimental), hypothesis testing (Parametric and non-parametric tests), generalization and interpretation of results. Use of statistical softwares/ packages in data analysis (SPSS, Graph Pad Prism).

Unit-III

Multivariate analysis: Introduction to multivariate analysis (Linear and non linear methods) and their validation methods (Statistical parameters).

Research ethics, plagiarism and impact of research: Research ethics, responsibility and accountability of the researchers, ethical consideration during animal experimentation including CPCSEA guidelines. Plagiarism and use of plagiarism detection softwares such as-VIPER. Impact of research on environment and society, commercialization of research, intellectual ownership.

Unit-IV

Technical writing and reporting of research: Types of research report: Dissertation and thesis, research paper, review article, short communication, conference presentation, meeting report etc. Structure and organization of research reports: Title, abstract, key words, introduction, methodology, results, discussion, conclusion, acknowledgement, references, footnotes, tables and illustrations. Impact factor, rating, indexing and citation of journals. Detailed study of 'Instruction to Authors' of any research journal, a thorough understanding of steps involved in submitting articles electronically to any research journal (Registration, new article submission, tracking process, submitting revised articles).

Unit-V

Funding agencies and research grants: Introduction to various research funding agencies such as-DST, DBT, AICTE, UGC, CSIR, ICMR, AAYUSH, and DRDO along with their function in India. Writing a research project and procurement of research grant. Project cost analysis.

SUGGESTED BOOKS:

1. Kothari C.R., Research Methodology Methods and Techniques, Wishwa Prakashan, New Delhi.
2. Lokesh K., Methodology of Educational research, Vikash Publishing House Pvt. Ltd., New Delhi.
3. Kumar R., Research Methodology, Dorling Kindersley (India) Pvt. Ltd., New Delhi.
4. Rao G.N., Research Methodology and Qualitative Methods, B.S. Publications, Hyderabad.
5. Saunders M., Lewis P. and Thornhill A., Research Methods for Business Students, Dorling Kindersley (India) Pvt. Ltd., New Delhi.
6. Bolton S. and Bon C., Pharmaceutical Statistics: Practical and Clinical Applications, Marcel Dekker, New York.
7. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, An introduction to Research Methodology, RBSA Publishers, Jaipur.
8. Fisher R.A. Statistical Methods for Research Works, Oliver and Boyd, Edinburgh.
9. Chow S.S. and Liu J.P., Statistical Design and Analysis in Pharmaceutical Sciences, Marcel Dekker, New York.
10. Buncher C.R., Statistics in the Pharmaceutical Industry, Marcel Dekker, New York.

MODERN PHARMACEUTICAL ANALYTICAL TECHNIQUES PRACTICAL (*MPA105*)

1. Determination of the wavelength of maximum absorbance (λ max) of given compounds by UV-Visible spectrophotometry.
2. Quantitative estimation of Pharmacopoeial compounds by UV-Visible spectrophotometry.
3. UV-Vis spectrophotometric assay of pharmaceutical formulations containing Pharmacopoeial compounds as active ingredients.
4. Simultaneous estimation of multi component containing formulations by UV-Visible spectrophotometry.
5. Quantitative estimation of caffeine in beverages using UV-Vis spectrophotometer.
6. Study and interpretation of the FT-IR/IR spectra of given compounds.
7. Separation of the organic compounds from given mixture by thin layer chromatography (TLC).
8. Isolation of the organic compounds from given mixture by two-dimensional thin layer chromatography (2D-TLC).
9. Separation and quantitative estimation of organic compounds in the given mixture by thin layer chromatography (Preparative TLC).
10. Column packing and separation of organic compounds with the help of column chromatography.
11. Simultaneous estimation of any marketed formulation using RP-HPLC method.
12. Stability studies of marketed formulation by RP-HPLC method as per ICH guidelines.
13. Estimation of Sodium/ Potassium by flame photometry.

PHARMACEUTICAL QUALITY ASSURANCE PRACTICAL-I (*MQA-104*)

The practicals may be chosen from the following suggested list of experiments based on the subjects opted in that particular semester-

1. Case studies on total quality management (TQM)
2. Case studies on out of specifications (OOS).
3. Case studies on out of trend (OOT).
4. Development of stability study protocol.
5. In process quality control tests for pharmaceutical formulations (tablets, capsules, parenterals, semisolid, etc.).
6. Finished product quality control tests for pharmaceutical formulations (tablets, capsules, parenterals, semisolid, etc.).
7. Assay of raw materials as per official monographs.
8. Testing of related and foreign substances in drugs and raw materials.
9. To carry out pre-formulation study for tablets, parenterals.
10. To study the effect of pH on the solubility of drugs.
11. Quality control tests for primary and secondary packaging materials.
12. Accelerated stability studies.
13. Determination of PKa value of drugs.
14. Organic contaminants residue analysis by chromatography.
15. Estimation of Metallic contaminants by flame photometer.
16. Assay of official compounds by UV-Visible spectrophotometry.
17. Interpretation of given spectra of IR, NMR and Mass.
18. Identification of antibiotic residue by TLC.
19. Qualification of following Pharma equipment: Autoclave; Hot air oven; Tablet compression machine.
20. Validation of an analytical method for a drug.
21. Validation of a processing area.
22. Qualification of at least two analytical instruments.
23. Cleaning validation of one equipment.
24. Preparation of master formula record.
25. Preparation of batch manufacturing record.
26. Qualification of pharmaceutical testing equipment (Dissolution testing apparatus, friability apparatus, disintegration tester)
27. Check list for bulk pharmaceutical vendors.
28. Check list for sterile production area.
29. Check list for water for injection.
30. Design of plant layout: Sterile and non-sterile area.

Second Semester

HAZARDS AND SAFETY MANAGEMENT (*MQA201*)

Unit-I

Multidisciplinary nature of environmental studies: Natural resources, renewable and non-renewable resources, natural resources and associated problems; Forest resources, water resources, mineral resources, energy resources, land resources.
Ecosystems: Concept, structure and function of an ecosystem.

Unit-II

Environmental hazards: Introduction, sources and types of hazards with reference to water, soil, air and radioisotopes, air circulation maintenance industry for sterile area and non sterile area. Preliminary hazard analysis (PHA).

Unit-III

Chemical based hazards: Sources of chemical hazards, hazards of organic synthesis, sulphonating hazard, organic solvent hazard, control measures for chemical hazards, management of combustible gases, toxic gases and oxygen displacing gases management, regulations for chemical hazard, management of over-exposure to chemicals and TLV concept.

Unit-IV

Fire hazards: Fire and explosion- Introduction and types, safety and hazards regulations. Fire protection system- Fire prevention, types of fire extinguishers and critical hazard management system, multiphase reactions, transport effects and global rates. Preventive and protective management from fires and explosion.

Unit-V

Hazard and risk management: Self-protective measures against workplace hazards. Critical training for risk management, process of hazard management, ICH guidelines on risk assessment and risk management methods and tools. Factory act and rules, fundamentals of accident prevention, elements of safety program and safety management, effluent treatment procedure, role of emergency services.

SUGGESTED BOOKS:

1. Singh Y.K., Environmental Science, New Age International Pvt. Publishers, Bangalore.
2. Quantitative Risk Assessment in Chemical Process Industries, American Institute of Chemical Industries, Centre for Chemical Process safety.
3. Erach B., The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmadabad.
4. Dikshith T.S.S., Hazardous Chemicals: Safety Management and Global Regulations, CRC Press, New York.

PHARMACEUTICAL VALIDATION (*MQA202*)

Unit-I

Introduction to validation: Definition of calibration, qualification and validation, scope, frequency and importance. Difference between calibration and validation. Calibration of weights and measures. Advantages of validation, organization for validation, validation master plan, types of validation, streamlining of qualification and validation process qualification: User requirement specification, design qualification, factory acceptance. Test (FAT)/ site acceptance test (SAT), installation qualification, operational qualification, performance qualification, re-qualification (Maintaining status- Calibration preventive maintenance, change management).

Unit-II

Qualification of manufacturing equipment: Dry powder mixers, fluid bed and tablet compression (Machine).
Qualification of analytical instruments: UV-Visible spectrophotometer, FTIR, DSC, GC, HPLC, HPTLC, LC-MS.

Unit-III

Qualification of laboratory equipments: Hardness tester, friability test apparatus, tap density tester, disintegration tester, dissolution test apparatus.
Validation of utility systems: Pharmaceutical water system and pure steam, HVAC system, compressed air and nitrogen.

Unit-IV

Process validation: Concept, process and documentation of process validation. Prospective, concurrent and retrospective validation, re-validation criteria, process validation of various formulations (coated tablets, capsules, ointment/creams, liquid orals and aerosols), aseptic filling: Media fill validation, USFDA guidelines on process validation- A life cycle approach. **Analytical method validation:** General principles, validation of analytical method as per ICH guidelines (Q2) and USP.

Unit-V

Cleaning validation: Cleaning method development, validation of analytical method used in cleaning, cleaning of equipment, cleaning of facilities, cleaning in place (CIP), validation of facilities in sterile and non-sterile plant.
Computerized system validation: Electronic records and digital signature - 21 CFR Part 11 and GAMP 5.

SUGGESTED BOOKS:

1. Loftus B.T. and Nash R.A., Pharmaceutical Process Validation, Drugs and Pharm Sci. Series, Vol. 129, Marcel Dekker Inc., New York.
2. Lachman L., Lieberman H.A., Karig J.L., The Theory and Practice of Industrial Pharmacy, CBS Publishers and Distributors, New Delhi..
3. Carlton F.J., and Agalloco J., Validation of Aseptic Pharmaceutical Processes, Marcel Dekker, New York.
4. Levin M., Pharmaceutical Process Scale-Up, Drugs and Pharm. Sci. Series, Vol. 157, Marcel Dekker Inc., New York.
5. Haider S.I., Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries, St. Lucie Press, A CRC Press Company, New York.
6. Cloud P.A., Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Interpharm/CRC Press, New York.
7. Carlton F. J., and Agalloco J., Validation of Pharmaceutical Processes: Sterile Products, 2nd Edition, Marcel Dekker, New York.

8. Chan C., Lam H., Lee Y.C., Zhang Y., Analytical Method validation and Instrument Performance Verification, Wiley Interscience, New Jersey.
9. Berry I.R. and Harpaz D., Validation Of Active Pharmaceutical Ingredients, CRC Press, New York.
10. Sharma P.P., Validation in Pharmaceutical Industry Concepts Approaches and Guidelines, Vandana Publications Pvt. Ltd., Delhi.

AUDITS AND REGULATORY COMPLIANCE (*MQA203/MQA101*)

Unit-I

Introduction: Objectives, management of audit, responsibilities, planning process, information gathering, administration, classifications of deficiencies.

Unit-II

Role of quality systems and audits in pharmaceutical manufacturing environment: cGMP Regulations, quality assurance functions, quality systems approach, management responsibilities, resource, manufacturing operations, evaluation activities, transitioning to quality system approach, audit checklist for drug industries.

Unit-III

Auditing of vendors and production department: Bulk pharmaceutical chemicals and packaging material vendor audit, warehouse and weighing, dry production: Granulation, tableting, coating, capsules, sterile production and packaging.

Unit-IV

Auditing of microbiological laboratory: Auditing the manufacturing process, product and process information, general areas of interest in the building raw materials, water, packaging materials.

Unit-V

Auditing of quality assurance and engineering department: Quality assurance maintenance, critical systems: HVAC, water, water for injection systems, ETP.

SUGGESTED BOOKS:

1. Ginsbury K., and Bismuth G., Compliance Auditing for Pharmaceutical Manufacturers, Interpharm/CRC Press, New York.
2. Gad S.C., Pharmaceutical Manufacturing Handbook: Regulations and Quality, Wiley-Interscience, New Jersey.
3. Baird R.M., Hodges N.A., Denyer S. P., Handbook of Microbiological Quality Control Pharmaceutical and Medical Devices, CRC Press, New York.
4. Singer D.C., Staden J.F.V., Stefan R., Laboratory Auditing for Quality and Regulatory Compliance. Taylor and Francis, New York.

PHARMACEUTICAL MANUFACTURING TECHNOLOGY (*MQA204/MQA102*)

Unit-I

Pharmaceutical industry developments: Legal requirements and licenses for API and formulation industry, plant location-factors influencing.
Plant layout: Factors influencing, special provisions, storage space requirements, sterile and aseptic area layout.
Production planning: General principles, production systems, calculation of standard cost, process planning, routing, loading, scheduling, dispatching of records, production control.

Unit-II

Aseptic process technology: Manufacturing, manufacturing flowcharts, in process-quality control tests for following sterile dosage forms: Ointment, suspension and emulsion, dry powder, solution (small volume and large volume).
Advanced sterile product manufacturing technology: Area planning and environmental control, wall and floor treatment, fixtures and machineries, change rooms, personnel flow, utilities and utilities equipment location, engineering and maintenance.
Process automation in pharmaceutical industry with specific reference to manufacturing of sterile semisolids. Monitoring of parenteral manufacturing facility, cleaning in place (CIP), sterilization in place (SIP), prefilled syringe, powdered jet, needle free injections, and form fill seal technology (FFS).

Unit-III

Non sterile manufacturing process technology: Manufacturing, manufacturing flowcharts, in process-quality control tests for following Non-Sterile solid dosage forms: Tablets (compressed and coated), capsules (Hard and Soft).
Advance non-sterile solid product manufacturing technology: Process automation in pharmaceutical industry with specific reference to manufacturing of tablets and coated products. Improved tablet production: Tablet production process, granulation and pelletization equipments, continuous and batch mixing, rapid mixing granulators, rota granulators, spheronizers and marumerisers and other specialized granulation and drying equipments. Problems encountered.
Coating technology: Process, equipments, particle coating, fluidized bed coating, and application techniques. Problems encountered.

Unit-IV

Containers and closures for pharmaceuticals: Types, performance, assuring quality of glass, types of plastics used, drug plastic interactions, biological tests, modification of plastics by drugs, different types of closures and closure liners, film wrapper, blister packs, bubble packs, shrink packaging, foil/ plastic pouches, bottle seals, tape seals, breakable seals and sealed tubes. Evaluation of stability of packaging material.

Unit-V

Quality by design (QbD) and process analytical technology (PAT): Current approach and its limitations. Why QbD is required, advantages, elements of QbD, terminology (QTPP, CMA, CQA, CPP, and RLD), design space, design of experiments, risk assessment and mitigation/minimization. Quality by design, formulations by design, QbD for drug products, QbD for drug substances, QbD for excipient, Analytical QbD. FDA initiative on process analytical technology. PAT as a driver for improving quality and reducing costs: Quality by design (QbD), QA, QC and GAMP. PAT guidance, standards and regulatory requirements.

SUGGESTED BOOKS:

1. Lachman L., Lieberman H.A., Karig J.L., The Theory and Practice of Industrial Pharmacy, Varghese Publishing House, Bombay.
2. Lachman L., Lieberman H. A., Schwartz J. B., Pharmaceutical Dosage Forms: Tablets, Vol. I-III, CBS

Publishers and Distributors, New Delhi.
3. Willig S. H., Tuckerman M. M., Hitchings IV W.S., Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control, Bhalani Publishing House, Mumbai.
4. Pharmacopoeia of India, Ministry of Health, Govt. of India.
5. United States Pharmacopoeia. United States Pharmacopoeial Convention, Inc, USA.
6. Dean D.A., Evans E.R., Hall I.H., Pharmaceutical Packaging Technology, Taylor and Francis, New York.
7. Gad S.C., Pharmaceutical Manufacturing Handbook: Regulations and Quality, Wiley-Interscience, New Jersey.
8. Bauer E.J., Pharmaceutical Packaging Handbook, Informa Healthcare, London.
9. Sinko P.J., Martin's Physical Pharmacy and Pharmaceutical Sciences, B. I. Publications Pvt. Ltd., Noida.
10. Banker G.S. and Rhodes C.T., Modern Pharmaceutics, Marcel Dekker Inc. New York.

BIOLOGICAL STANDARDIZATION & QUALITY CONTROL (*MQA205*)

Unit-I

Good clinical practice: Provisions, prerequisites and protocol for a clinical trial, protection of trial subjects, responsibilities of the investigator, sponsor and monitor, monitoring of safety, record keeping and handling of data, handling and accountability for pharmaceutical products, role of the drug regulatory authority, quality assurance for the conduct of a clinical trial, consideration for multicentre trials.

Unit-II

In Process quality control: In process quality control for tablets, capsules, parenterals, ophthalmic preparations, ointments and liquid orals.
ISO 9001: Scope, requirements, design and development, management responsibilities, resource management, product realization.

Unit-III

Pyrogens-Production and properties of bacterial pyrogens and endotoxins, mechanism of action of pyrogens. Analytical testing of pyrogens as per IP, BP and USP. Interpretation of data in comparison with other official pyrogen tests. Determination methods of microbial counts and bio-burden.

Unit-IV

Biological standardization: Detailed study of principles and procedures involved in the biological assays of the following: Adsorbed diphtheria vaccine, adsorbed tetanus vaccine, heparin sodium, oxytocin, pertussis vaccine, plague vaccine, rabies antiserum, rabies vaccine, streptokinase, tetanus antitoxin, tuberculin purified protein derivative, typhus vaccine.

Unit-V

Quality assurance of herbal products: Determination of physical constants and chemical constants such as extractive values, moisture content, alcohol content, volatile oil content, ash value, bitterness values, foaming index, filth, insoluble matter, swelling factor. Significance of UV, IR, HPLC, HPTLC and mass spectroscopy in analysis of herbal products.

SUGGESTED BOOKS:

1. Khar R.K., Vyas S.P., Ahmad F.J., Jain G.K., Lachman/Lieberman's The Theory and Practice of Industrial Pharmacy, CBS Publishers and Distributors Pvt. Ltd., New Delhi.
2. Willig S.H., Tuckerman M.M., Hitchings IV W.S., Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control, Bhalani Publishing House, Mumbai.

3. Lachman L., Lieberman H. A., Schwartz J.B., Tablets, Vol. I-III, CBS Publishers and Distributors, New Delhi.
4. Block J.H., Roche E., Soine, T. and Wilson, C., Inorganic, Medicinal and Pharmaceutical Chemistry, Lea and Febiger.
5. Atherden L.M., Bentley and Driver's Text Book of Pharmaceutical Chemistry, Oxford University Press, Oxford.
6. Carratt D. C., The Quantitative analysis of Drugs, CBS Publishers, New Delhi.
7. The International Pharmacopoeia, Vol. I-V, General Methods of Analysis and Quality Specification for Pharmaceutical Substances, Excipient and Dosage forms, WHO, Geneva.
8. Pharmacopoeia of India, Ministry of Health, Govt. of India.
9. Florey K., Analytical Profile of Drug Substance (All volume), Academic Press, Elsevier, Amsterdam.
10. Brittan H. G., Analytical Profiles of drug substances and Excipients, Volume 23, Academic Press, Cambridge.
11. Joseph C., The Analysis of Drugs in Biological Fluids, CRC Press, New Jersey.
12. World Health Organization, WHO guidelines on Safety Monitoring of Herbal Medicines in Pharmacovigilance Systems, Geneva.
13. Choudhary R.D., Herbal Drug Industry, Eastern Publisher, New Delhi.
14. Wagner H., Bladt S., Plant Drug Analysis, Springer, New York.
15. Thomson R.H., The Chemistry of Natural Products, Springer, New York.
16. Ikan R., Natural products: A Laboratory Guide, Elsevier, Amsterdam.
17. Paech K., Tracey M.V., Modern Methods of Plant Analysis, Vol. 1 and 2, Springer Science and Business Media, Heidelberg.
18. Harborne A.J., Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis, Springer Science and Business Media, Heidelberg.

PHARMACEUTICAL QUALITY ASSURANCE PRACTICAL-I (*MQA-206*)

The practicals may be chosen from the following suggested list of experiments based on the subjects opted in that particular semester-

1. Case studies on total quality management (TQM)
2. Case studies on out of specifications (OOS).
3. Case studies on out of trend (OOT).
4. Development of stability study protocol.
5. In process quality control tests for pharmaceutical formulations (tablets, capsules, parenterals, semisolid, etc.).
6. Finished product quality control tests for pharmaceutical formulations (tablets, capsules, parenterals, semisolid, etc.).
7. Assay of raw materials as per official monographs.
8. Testing of related and foreign substances in drugs and raw materials.
9. To carry out pre-formulation study for tablets, parenterals.
10. To study the effect of pH on the solubility of drugs.
11. Quality control tests for primary and secondary packaging materials.
12. Accelerated stability studies.
13. Determination of PKa value of drugs.
14. Organic contaminants residue analysis by chromatography.
15. Estimation of Metallic contaminants by flame photometer.
16. Assay of official compounds by UV-Visible spectrophotometry.
17. Interpretation of given spectra of IR, NMR and Mass.
18. Identification of antibiotic residue by TLC.
19. Qualification of following Pharma equipment: Autoclave; Hot air oven; Tablet compression machine.
20. Validation of an analytical method for a drug.
21. Validation of a processing area.

22. Qualification of at least two analytical instruments.
23. Cleaning validation of one equipment.
24. Preparation of master formula record.
25. Preparation of batch manufacturing record.
26. Qualification of pharmaceutical testing equipment (Dissolution testing apparatus, friability apparatus, disintegration tester).
27. Check list for bulk pharmaceutical vendors.
28. Check list for sterile production area.
29. Check list for water for injection.
30. Design of plant layout: Sterile and non-sterile area.

SYNOPSIS (SEMINAR-I) (*MQA207*)