Far Western University
Mahendranagar, Kanchanpur
Faculty of Science and Technology



B. Sc. Eighth Semester Physical Group

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Environmental Assessment and Management System** Credit: **4**

Course Code: **ENV 481** Number of hours per week: **4**

Nature of the Course: Core Course (**Theory)** Total hours: **60**

Year: **Fourth** Semester: **Eight**

Level: **B.Sc.**

Course Objectives

Upon completion of the course, the students should be able to:

Understand linkages between development and environment
Assess environmental impacts on various steps of project cycle
Take insights on environmental management system
Identify and analyze the environmental consequences due to developmental projects
Understand legal aspects in environmental assessment in national and international context

Specific Objectives	Contents
• Understand linkages between development and environment • Understand importance of environmental assessment in reconciling development and environment	**Unit I: Introduction to Environmental Assessment (7 Hrs)** Development and environmental consideration; Tools for the environment inclusion in Development; Initiation of Environmental Assessment; History of Environmental Assessment; Legal requirement of Environmental Assessment; Project development; Components of project cycle; Environmental inclusion on various steps of project cycle;
• Acquaint with environmental assessment process (in context of Nepal) • Differentiate between IEE and EIA • Know methods of collecting baseline information	**Unit II: Environmental Assessment Process (12 Hrs)** Environment Assessment (EA) and its types; The EA Process; Environmental screening; Scoping to determine the Terms of Reference (TOR); Terms of Reference; Initial Environmental Examination (IEE)/Environmental Impact Assessment (EIA)(differences); Types of impact; Baseline information (physical, biological, social, economic and cultural environment); Methods of collecting baseline information; Issues identification; Mechanism to give the weightage for issues; Prioritization of issues; Project Alternatives Analysis; Potential Impact Identification
• Understand different	**Unit III: Impacts Assessment Techniques (10**

methods of impact identification • Know methods of impact prediction	**Hrs)** Methods of impact identification: Checklist, interaction matrix, overlay mapping, networks, GIS, task specific computer model, expert system; Impact prediction: introduction, method of impact prediction, uncertainty of impact prediction, impact ranking and comparison of alternatives; Evaluation and determination of significance; Categorization of impacts
• Understand various impact mitigation measures including public participation	**Unit IV: Impact Mitigation Measures (5 Hrs)** Mitigation measures; Public participation and consultations; Challenges and opportunities of public involvement; Environmental Management Plan (EMP)
• Get insights on environmental monitoring and auditing • Take insights on quality and review of EIA reports	**Unit V: Environmental Monitoring and Auditing (7 Hrs)** Monitoring: introduction and types of monitoring, monitoring criteria and methodologies, monitoring indicators and monitoring processes; Environmental auditing: introduction, types of audit, timeframe for conducting audit, environment auditing plan; Quality and review of EIA reports
• Understand environmental management system with different tools and their application • Introduce quality management system • Know different stages of EMS implementation and certification process of EMS	**Unit VI: Environmental Management System (12 Hrs)** Environmental management tools and their application: Green Productivity (GP), Environmental Management System (EMS), Cleaner Production (CP) and Life Cycle Assessment (LCA); Introduction to International Organization for Standardization (ISO) and ISO 14000 series; Historical development of EMS; Introduction and requirements of EMS; Introduction of Quality Management System (QMS); Stages of EMS implementation; environmental review, identification of significant environmental aspects, documentation requirements of EMS, environmental policy, objectives, targets and programs, operation control, review; Certification process of EMS; EMS auditing and Mechanism for certification in Nepal
• Understand Environmental Assessment related legal aspects in Nepal	**Unit VII: Legal Aspects in Environmental Assessment (7 Hrs)** Environmental Assessment related legal aspects in Nepal; National legislative framework: Environment Protection Act (EPA), Environment Protection Rule (EPR); Sectoral environmental

	legislations: national strategy, plans and polices, guidelines, manuals and standards; Legislative framework; International convention and treaties; Major international conventions adopted by Nepal

References

1. Brady J., 2006 (Eds.). Environmental Management in Organizations, The Institute for Environmental Management, First South Asian Edition, Earthscan, London.
2. Environment Protection Act 1997 and Environment Protection Rules, 1997. Ministry of Environment, Science and Technology, Nepal
3. ISO. (2004). International Standard ISO 14001, Reference No. 14001:2004 (E), International Organization for Standardization, Geneva.
4. ISO, 2015. ISO 14001:2015. International Organization of Standardization, Geneva, Switzerland. ISBN: 978-67-10648-9.
5. Khadka, R.B. (1997). EIA Training Manual for Professionals and Managers. Asian Regional Environmental Assessment Program. IUCN, Kathmandu, Nepal.
6. Khadka, R.B., Gorzula, S., Joshi A.R., Guragain, S., Mathema, A.B. (2013). Environmental Impact Assessment: Process, Methods and Practices in South Asia (Bangladesh, Bhutan, India and Nepal), 1st edition. SchEMS and IED/RCBI, New Baneshwor.
7. Lohani B.N., Evans J.W., Robert R., Richard A, and Liang S. (1997). Environmental Impact Assessment for Developing Countries in Asia: Overview and selected case studies, Volume I & Volume II. Asian Development Bank.
8. NPC and IUCN (1993). National Environmental Impact Assessment Guidelines. National Conservation Strategy Implementation Project, Kathmandu.
9. Rijal, K. and Sapkota, R.P. (2012). Environmental Management Systems: Concept and Approaches, Printwell Offset Press, Kathmandu, Nepal.
10. The World Bank. (1999). World Bank Safeguards Policies – Environmental Assessment. Washington, DC: World Bank.
11. Uprety, B.K. (2003). Safeguarding the Resources, Environment Impact Assessment, Process and Practices. Shikhar Samundra Offset, Bagbazar, Kathmandu.

FAR WESTERN UNIVERSITY FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Environmental Economics** Credit: **4**
Course Code: **ENV 482** Number of hours per week: **4**
Nature of the Course: Core Course (**Theory)** Total hours: **60**
Year: **Fourth** Semester: **Eight**
Level: **B.Sc.**

Objectives

Upon completion of the course, the students should be able to:

- Understand the economic approaches, methods and tools to address environmental issues
- Have understanding about the linkages between economy and environment
- Familiarize with methods and tools adopted for environmental valuation and be able to diagnose the environmental issues from an economic prospective

Specific Objectives	**Contents**
• Understand interdependence between economy and environment	**Unit I: Introduction (8 Hrs)** Introduction to natural resource and environmental economics; Emergence of resource and environmental economics; Fundamental issues in economic approach to resource and environmental problems; Origin of sustainability problem; Economy-Environment interdependence; Drivers of environmental impact; Poverty and inequality; Limits to growth; Pursuit of sustainable development
• Understand fundamentals of environmental economics • Get insights on various contemporary issues in environmental economics	**Unit II: Environmental Economics (12 Hrs)** Concept, scope and origin of environmental economics; Inter-linkages between economy and environment; Market economy: Notion of market, Perfectly competitive market and resource allocation, Pareto criterion of efficiency; Market failure (Lack of property rights, Externalities, Asymmetric information); Type of goods (Private, club, common and public goods); Contemporary issues in environmental economics (Climate change, Sustainable development, Poverty, Carbon

	Credit, Clean Development Mechanism (CDM), Reducing Emission from Deforestations and Forest Degradations (REDD); Experience and examples from Nepal on Carbon Credit, CDM and REDD
• Know various types of natural resources • Understand scarcity of natural resources and its consequences	**Unit III: Economics of Natural Resources (8 Hrs)** Types of resources: Renewable and non renewable; Theories of natural resource use: Elementary capital theory, Models for renewable resources with logistic growth and maximum sustainable yield, Models for non renewable resources; Natural resource scarcity; Resource substitutability and consequences of increasing resource scarcity; Social welfare function and optimal allocation of natural resources; Example of commercial forestry economics from Nepal
• Acquaint with various instruments for achieving pollution control targets	**Unit IV: Economics of Pollution Control (10 Hrs)** Criteria for choice of pollution control instruments; Cost efficiency and cost-effective pollution abatement instruments; Instruments for achieving pollution abatement targets; Economic incentive (quasi-market) instruments; Comparison of relative advantages of command and control, emissions tax, emission abatement subsidy and marketable permit instruments
• Know various methods and techniques for valuation of environmental goods and services • Understand the importance of payment for ecosystem services (PES) in Nepalese context	**Unit V: Ecosystem Services and Natural Capital (16 Hrs)** Introduction to ecosystem services and goods; Types of ecosystem services; Valuation of environmental goods and services: Dimensions of value, Benefit Cost Analysis (BCA) (Meaning, Components and Steps) with examples and calculations, Market vs. non market valuation; Theory of environmental valuation; Methods for valuing environmental costs and benefits: Contingent Valuation method (CVM), Willingness to Pay (WTP) and Willingness to Accept (WTA), Travel Cost Method (TCM), Hedonic Pricing Method) with examples and calculations; Payment

	for ecosystem services: Theoretical perspectives, Opportunities, Approaches and Deals; Examples of PES from Nepal
• Know theory and practice of accounting for environment	**Unit VI: Accounting for Environment (6 Hrs)** Environmental indicators; Environmental accounting theory; Environmental accounting practice; Sustainability indicators; Alternative measures of economic welfare and Green accounting; Green economy and green governance

References

- Barry, F. and Martha, K.F. (2012). Environmental economics. McGraw Hill Education, East Windsor.
- Butlin, J.A. (1981).The economics of environmental and natural resources policy. West-view Press, Colorado.
- Collard, D. (1989). Economics, growth and sustainable environments. St. Matin's Press, New York.
- Constanza, R. (1991). Ecological economics: the science and management of sustainability. Colombia University Press, US.
- Fisher, A.C.T. (1981). Resource and environmental economics. Cambridge University Press, New York.
- Kolko, J. (1988) .Reconstructing the world economy. Pantheon, New York.
- Pearce, D.W. (1972). Environmental economics. New ed. Longman, London.
- Perman, R., Y Ma, J McGilvray and M Common. (2003). Natural Resource and Environmental Economics. Pearson Education Limited, Harlow, London.
- UNEP. (2008). Payments for ecosystem services getting started: a primer. UNEP, Nairobi.
- WCED. (1987). Our common future. World Commission on Environment and Development, Oxford University Press, New York.

FAR WESTERN UNIVERSITY
FACULTY OFSCIENCE AND TECHNOLOGY

Course Title: **Environmental Assessment and Management System (Practical)**

Course Code: **ENV 483** Credit: **2** Number of hours per week: **6**

Nature of the Course: Core Course (**Practical)** Total hours: **90**

Year: **Fourth** Semester: **Eight**

Level: **B.Sc.**

Course Objectives

Upon completion of the course, the students should be able to:

Carry out environmental assessment (IEE/EIA) of development projects
Identify and analyze the environmental consequences due to developmental projects
Prepare Environmental Management Plan (EMP) of development works
Review IEE/EIA reports and comment on the quality of environmental assessment reports

Practical

1. Carry out environmental assessment (IEE/EIA) of any development projects (identify impacts, predict impacts, rank impacts and compare alternatives).
    a. Road construction
    b. Dumping/landfill site construction
    c. Hospital construction
    d. Hotel construction

    (*The practical involves Case Study approach. It essentially involves preparation of baseline information related to physical, biological, socio-economical and cultural environments. Further, it also identifies mitigation measures for the identified impacts and prepares environmental monitoring and auditing plan*.)
2. Prepare Environmental Management Plan (EMP) of Development Works (as mentioned in Practical 1)
3. Review of IEE/EIA reports
    (*Students will go through available IEE/EIA reports and critically/thoroughly examine the different sections of reports, prepare review reports and comment upon the quality of the reports. This will familiarize students with the different components of the IEE/EIA reports and help them prepare better quality reports in their future endeavours/assignments*.)

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Ecosystem Services Management** Credit: **3**

Course Code: **ESM 484** Number of hours per week: **3**

Nature of the Course: **Theory (Interdisciplinary)** Total hours: **45**

Year: **Fourth** Semester: **Eighth**

Level: **B.Sc.**

Course Objectives

After the completion of the course, students should be able to

- Understand the basic concepts of ecosystem theories, ecosystem services, resilience & adaptability, payment for ecosystem services
- Develop ecological indicator, analyze and evaluate ecosystem services, asses human environmental system and landscape capacities to provide ESs,
- Understand the role of ecosystem service approach in natural resource management and effect on human beings
- ware on key national and international institutional Framework/ Policy/Program related to ecosystem services

Specific Objectives	**Contents**
• Understand the basic concepts of ecosystem theories	**Unit I: Introduction (7 Hrs)** Ecosystem: structural components, functional components; Energy sources for ecosystem dynamics; Ecosystem metabolism (Primary and secondary production); Biogeochemical cycles; Ecological stability; Homeostasis and feedback mechanism; Human impacts on ecosystem
• Understand ecosystem services along with typology • Understand the relation between ecosystem services, ecological resilience and adaptability	**Unit II: Ecosystem Services (8 Hrs)** Concepts of ecosystem services and evolution of the concept; Typology of ecosystem services; Overview of ecosystem service cascade; Biodiversity and ecosystem services; Relation between ecosystem services, ecological resilience and adaptability; challenges of ecosystem services; issues/threats to the ecosystem
• Know various techniques and methods for valuation and quantification of ecosystem services	**Unit III: Evaluation and Quantification of Ecosystem Services (10 Hrs)** Ecosystem functions; Major ecosystem services; Services from various types of ecosystems; Classification for valuation of ecosystems services: types of evaluation of ecosystem services (ecological and economic

	valuation); Economic value of ecosystem service; Consumptive use; productive use; Assessment/analysis of ecosystem services; Quantification of ecosystem services; Analysis of ecosystem services tradeoffs
• Acquaint with the piloting and implementation of PES (Payment for Ecosystem Services)	**Unit IV: Payment for Ecosystem Services (PES) (10 Hrs)** Definition of PES; PES practices in national and international level; Development of PES mechanism; Stakeholders: service providers, beneficiaries & intermediaries; Guidelines of piloting and implementation of PES mechanism; PES as a viable option for financing biodiversity conservation and management
• Know different categories of Protected in Nepal • Understand the role of protected areas for ecosystem services	**Unit V: Protected Areas and Ecosystem Services (6 Hrs)** Protected areas in Nepal; Categorization of protected areas in Nepal; IUCN Management Categories of Protected Areas; Need and importance of protected areas for ecosystem services; Ecosystem services and ecotourism; Pollution and impact on ecosystem services; Ecological restoration
• Understand policy perspectives on ecosystem services management	**Unit VI: Policy Perspectives on Ecosystem Services Management (4 Hrs)** Relevant policies and laws (PES Policy); Ecosystem service governance; Challenges, limitations and opportunities for ecosystem services management; Involved institutions

References

1. Alberini, A. and Kahn, J.R. (2006). Handbook on Contingent Valuation. Edward Elger Publishing Ltd., ISBN 13: 9781-84064-2087
2. Bennett, J. (2011). The International Handbook on Non-market Environmental Valuation. Edward Elger Publishing Ltd., ISBN 978-1-84844-425-6
3. Burkhard, B. and F. Müller (2008) Drivers-Pressure-State-Impact-Response. In: Joergensen, S.E. & B.D. Fath (Eds.): Ecological Indicators 2 of Encyclopedia of Ecology 5. Oxford: Elsevier: 967-970
4. Burkhard, B., F. Kroll, F. Müller and W. Windhorst. (2009). Landscapes' Capacities to Provide Ecosystem Services – a Concept for Land-Cover Based Assessments. *Landscape Online* 15: 1-22
5. Carl Folke, C. (2006). Resilience: The Emergence of a Perspective for Social–Ecological Systems Analyses. *Global Environmental Change* 16: 253–267.

6. Costanza, R. (2009). Handbook of ecological indicators for assessment of ecosystem health, CRC Press/ Taylor and Francis, ISBN 1439809364, 9781439809365.
7. Daily, G.C. (1997). Introduction: What are ecosystem services? In G. Daily, editor. Nature Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, D.C Costanza.
8. de Groot, R.S., Wilson, M.A. and Boumans, R.M. (2002). A Typology for the Classification, Description and Valuation of Ecosystem Functions, Goods and Services. *Ecological Economics,* 41: 393–408.
9. R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, O.V., Paruelo, J.M., Raskin, R.G., Sutton, P. and van den Belt, M. (1997). The Value of the World's Ecosystem Services and Natural Capital. *Nature,* 387: 253–260.

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Course Title	**Integrated Water Resource Management**	Credit	**3**
Course Code	**ENV 485**	Number of hours per week	**3**
Nature of the Course	**Theory (Core Course)**	Total hours	**45**
Year	**Four**	Semester	**Eight**
Level	**B.Sc.**		

Course Objectives

Upon completion of this course Student will able to

- Acquaint with the principles and applications of IWRM.
- Make an understanding of relation between disaster and climate change with waterresources.
- Provide knowledge on wise use of water in various sectors.
- Provide knowledge on water resources planning and management.

Specific Objectives	Units, Contents and Credit Hours
• Understand the basics of integrated water resource management (IWRM)	**Unit I: Basics of IWRM (5 hours)** Concept of Integration; Principle of IWRM; Pillars of IWRM; Factors affecting IWRM; Concept of Integrated Watershed Management; Concept of Integrated River Basin Management
• Understand the wise use freshwater resources in agriculture and aquaculture • Understand the wise use freshwater resources in hydropower • Acquaint with the scenario of water supply and sanitation • Understand the urban andindustrial water management	**Unit II: Wise use of Freshwater Resources (15 hours)** **Agriculture and Aquaculture** Water use efficiency of crop and its improvement : crop water requirements and practical irrigation scheduling , irrigation types, irrigation water quality and environmental impacts aquaculture technique and its water quality **Hydropower Development** Types and components of hydropower plants; reservoir design and function storage zones; capacity yields relation; fixation of reservoir capacity with mass curve determination of reservoir capacity for a given yield from a reservoir of given capacity; estimation of demands and optimized reservoir operations; flood

	routing : sedimentation , trap efficiency and life of a reservoir; silting control and water quality management; environmental flow: concept, estimation and Nepalese perspectives; **Water supply and Sanitation** Water sources and availability; Water supply and sanitation: trend and status; factors affecting water demand; water supply design criteria and distribution system; problem for supply of water; key principles of ecological sanitation; simplified sewerage; decentralized water and sanitation systems. **Urban and Industrial Water Management** Water ecosystem in urban areas; effects of urbanization on water resources; water footprint; management of urban water; industrial water use; hydrological view point for feasibility for industrialdevelopment new technologies applied in water useand waste water in industrial sectors.
• Understand climate changeimpacts on water resources	**Unit III: Climate Change (5 hours)** Climate change impacts on Water resource; Projection of changes in availability of drinking water and its demand; Estimation of Changes in Hydrological Parameters: Rainfall, Snow, Evapo-transpiration, Soil Moisture and Runoff; Vulnerability of water resources due to climate change; Mitigation and Adaptation measures and their effectiveness
• Understand various aspects ofwater induced disasters	**Unit IV: Water Induced Disasters (5 hours)** Landslides and Erosion; Flood and Inundation; Glacial Lake outburst Floods; Landslide dam Outburst Floods; Drought; Cloud burst; Effect of changes in monsoon pattern on water resources; Hazard probability and risk; Risk and Vulnerability Mapping of water induced disasters; Cases studies in water induced disasters

• Take knowledge on water governance and policy in regional, national and global contexts	**Unit V: Water Governance and Policy (5 hours)** Water Governance: Introduction; Riparian Rights; Trans-boundary aspects of Water governance; Issues of water Governance; Water Governance Initiatives (International): Millennium Development Goals and other water course laws; Water Governance (Nepal): water Policy of Nepal, water Resources strategy, Nepal water Plan; Water Treaties: National and International
• Understand the fundamentals of water resources planning andmanagement	**Unit VI: Water Resources Planning and Management (10 hours)** Water Resource Planning: Basic Concepts; Multipurpose project: Objectives and Economics; Water demand Assessment; Cost Benefit Analysis in water resource planning; Water resources management tools and approaches: Inter Basin Transfer, Taping Groundwater, Rainwater harvesting, Construction of Dam , indigenous technologies; Institutional Arrangements in water resources management; Case studies Water Resource planning and Management in Nepal

Reference Books

1. Miller, Jr. G.T., 2010. Environmental Science. Thirteen Edition. Brooks/Coles Ceenage learning, USA
2. APHA, 1998. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, DC.
3. Goel, P.K., 2001. Water pollution: Causes, Effects and Control, New age International publishers
4. Asthana and Asthana 2010. Environment: Problems and solutions, S. Chand and Company ltd.

FAR WESTERN UNIVERSITY
FACULTY OFSCIENCE AND TECHNOLOGY

Course Title: **Disaster Risk Management** Credit: **3**

Course Code: **ENV 486** Number of hours per week: **3**

Nature of the Course: Elective course (**Theory -Interdisciplinary)** Total hours: **45**

Year: **Fourth** Semester: **Eight**

Level: **B.Sc.**

Course Objectives

Upon completion of the course, the students should be able to:

1. Understand the concept of hazard, disaster, vulnerability, exposure and risk.
2. Identify key stakeholders involved in DRM in Nepal.
3. Acquire the knowledge of DRR practices and policies.
4. Assess vulnerability and risk assessment
5. Know the criteria for building risk resilient community

Specific Objectives	Contents
• Understand the terminology on DRR.	**Unit I: Understanding DRM (5Hrs)** Definition of hazard, vulnerability, exposure, risk; DRR and DRM; Hazard typology; Environmental degradation and disaster; DRR and climate change adaptation linkages.
• Develop ideas on disaster scenario and DRR stakeholders in Nepal.	**Unit II: Disaster in Nepal (5Hrs)** Spatial distributions of disasters; Documentations of disaster events in Nepal; Loss and damage scenario of disaster in Nepal; Disaster stakeholders in Nepal.
• Assess vulnerability and disaster risk.	**Unit III: Vulnerability and Risk Assessment (10 Hrs)** Conceptual framework of hazard, vulnerability and risk; Elements at risk; Types of vulnerability; Vulnerability and risk assessment approaches and methods.
• Understand key mitigations measures for reducing disaster risk.	**Unit IV: Disaster Mitigation Measures (10 Hrs)** Disaster risk and its influencing factors; Structural and non-structural mitigation measures; Coping and adaptation measures for risk reduction.
• Acquire the knowledge of building risk resilient community.	**Unit V: Risk Resilience (5 Hrs)** DRR and biodiversity conservation; DRR and sustainable development; Community

	based and ecosystem based approach for risk resilience; DRR and Gender; Mainstreaming DRR into Development; Minimum characteristics of risk resilient community.
• Acquire knowledge on global and national initiatives on DRR.	**Unit VII: DRM Practices and Policy in Nepal (10 Hrs)** Global and National evolution of DRM; DRM cycle; Comprehensive and community based DRR; Participatory disaster risk assessment tools; Cluster Approach on DRM; Legislation on DRM in Nepal; Hyogo and Sendai Framework for Action.

References

1. Birkmann, J. (2006). Measuring vulnerability to promote disaster-resilient societies: conceptual frameworks and definitions. In: Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies. Birkmann, J. (ed.). United Nations University Press, Tokyo, Japan
2. Bryant, E. (2005). Natural Hazards. Cambridge University Press,Cambridge.
3. MoHA and DPNet-Nepal. (2011). Nepal disaster report: Policies, practices and lessons. Ministry of Home Affairs, Government of Nepal and Disaster Preparedness Network Nepal. Kathmandu, Nepal.
4. Sharma, A. P. (2011). Integrating climate change adaptation and disaster risk reduction. NGO Network Bulleting on Climate Change, Issue 4, October 2011, LIBIRD, Pokhara.
5. Shaw, R. and Krishnamurthy, R.R. (2009): Disaster Management: An Overview. In Shaw, R. and Krishnamurthy, R.R (Eds.). Disaster Management: Global Challenges and Local Solutions. University Press (India), Private Limited. Hyderabad Inida.
6. TU-CDES and UNDP (2015). Disaster Risk Management: Concept, Policy and Practices in Nepal. Strengthening DRM in Academia, Tribhuvan University, Central Department of Environmental Science, Kirtipur Nepal and United Nations Development Programme, Pulchowk, Lalitpur.
7. UNISDR, (2009). Terminology on disaster risk reduction. United Nations International Strategy for Disaster Reduction. Geneva, Switzerland.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Chemistry X F.M.: 100
Course No.: CHM 481 P.M.: 45%
Nature of Course: Theory Credit: 4
Level: B. Sc. Number of hours per week: 4
Year: Fourth, Semester: Eighth Teaching Hours: 60

1. Course Description:

The course intends to enable the students to be acquainted with the knowledge of advanced chemistry in all three branches of physical, organic and inorganic chemistry. Students will be familiarized with the fundamentals of the classification of solids based on band theory, structure determination & defects of solid crystals, quantum chemistry & statistical mechanics, structural determination of different organic compounds using various spectroscopic methods, coordination complexes especially their IUPAC nomenclature, isomerism, bonding, spectra and magnetism.

2. Course Objectives:

The general objectives of the course are as follows:

- To familiarize the students with fundamental knowledge of the classification of solids based on band theory, structure determination & defects of solid crystals, fundamentals of quantum chemistry & statistical mechanics.
- To enable the students to elucidate the structure of organic compounds by mass spectrometry, infrared, nuclear magnetic resonance and ultraviolet spectroscopic methods and conjugated compounds.
- To enable the students with basic knowledge of IUPAC naming of coordination complexes and acquaint them with different types of isomerism.
- To familiarize the students with basic concept of valence bond theory and crystal field theory to explain the nature of bonding, spectra and magnetism of coordination complexes.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Explain the salient features of bandtheory of solid. • Describe different types of bands in solids/crystals. • Discuss the classification of solids on the basis of band formation and properties of conductor, semiconductor, insulator and superconductors.	**Physical Chemistry** **Unit I: Band Theory of Solids (3 hrs)** Band theory of solid, types of bands in solid/crystal, classification of conductor, semiconductor, insulator and superconductor solids based on the formation of band and their properties.
• Describe the interplanar distance in cubicsystem. • Explain the Bragg's method of crystal analysis. • Derive the Bragg's equation & discuss its application to determine the interplanar distance, wave length of X-ray & structureof NaCl and KCl crystals. • Qualitative discussion on different types of crystal defects like point, line & plane defects. • Explain the color centers & F-center formation.	**Unit II: Structure and Defects of Crystals (7 hrs)** Interplanar distance in cubic system, Bragg's method of crystal analysis, Bragg's equation and its applications, calculation of interplanar distance (d) and wave length of X-ray (λ), structure of NaCl and KCl crystals, crystal defects: point defects- Frenkel, Schottky & self-interstitial, line defects- edge & screw dislocations, plane defects- grain boundary & stacking faults, color centers and formation of F-centre.

• Introduce the quantum chemistry and describe its historical background. • Describe about the wave-particle duality. • Derive the time independent Schrödinger	**Unit III: Quantum Chemistry (6 hrs)** Introduction, historical background of quantum mechanics (Max Planck to Schrödinger), wave-particle duality, time independent Schrödinger
wave equation. • Show that [ ] [ ]^2 = □*□ is the probability distribution function of the system. • Describe the terms of orthogonality & normalization and their conditions. • State & explain briefly the postulates of quantum mechanics.	wave equation, wave function and probability, concept of orthogonaland normalized wave functions, postulates of quantum mechanics.
• Introduce and explain the history of the statistical mechanics. • Explain the concepts of phase space, ensemble. • Derive an equation showing the relation between entropy & thermodynamic probability. • Obtain a final expression of Maxwell- Boltzmann distribution equation & evaluate the Maxwell-Boltzmann constants.	**Unit IV: Statistical Mechanics (4 hrs)** Introduction, history of statistical mechanics, concept of phase space, ensemble, entropy and thermodynamic probability, distribution of identical but distinguishable particles, Boltzmann distribution law.
• Explain the modern spectroscopic techniques of structure elucidation of organic compounds. • Discuss about the principle and techniques of mass spectrometry in structure elucidation. • Explain the mass spectra of small molecules. • Describe the instrumentation of mass spectrometer. • Describe the mass spectra of different functional groups. • Discuss the properties of electromagnetic spectrum. • Explain the principle and instrumentation of IR spectrophotometer. • Explain the IR spectrum of different functional groups.	**<u>Organic Chemistry</u>** **Unit V: Structure Determination– Mass Spectrometry and Infrared Spectroscopy (7 hrs)** Mass spectrometry of small molecules: magnetic-sector instruments, interpreting mass spectra, mass spectrometry of some common functional groups, mass spectrometry in biological chemistry: time of flight (TOF) instruments, spectroscopy and the electromagnetic spectrum, infrared spectroscopy, interpreting infrared spectra, infrared spectra of some common functional groups.

• Discuss the principle, instrumentation and application of NMR spectroscopy in structure elucidation of organic compounds. • Explain the NMR phenomenon and chemical shift value. • Describe the applications of 13C-NMR spectroscopy in structure elucidation of organic compounds. • Discuss the meaning and applications of chemical shift, spin- spin coupling and coupling constant in structure elucidation. • Explain the spectra of some simple organic compounds. • Describe the meaning of integration value in NMR. • Discuss the some more complex spectra of organic compounds.	**Unit VI: Structure Determination– Nuclear Magnetic Resonance Spectroscopy (5 hrs)** Nuclear magnetic resonance spectroscopy, the nature of NMR absorption, chemical shift, ^{13}C-NMR spectroscopy: signal averaging and FT-NMR, characteristics of ^{13}C-NMR spectroscopy, DEPT ^{13}C-NMR spectroscopy, uses of ^{13}C-NMR spectroscopy, ^{1}H-NMR spectroscopy and proton equivalence, chemical shift in ^{1}H-NMR spectroscopy, integrationof ^{1}H-NMR absorption: proton counting, spin-spin splitting in ^{1}H-NMR spectra, more complex spin-spin splitting patterns, uses of ^{1}H-NMRspectroscopy.
• Describe the structure and stability ofdienes. • Discuss electrophilic addition reactions ofsome conjugated dienes. • Explain the stability of allylic carbocation. • Describe the kinetics and thermodynamiccontrol reactions.	**Unit VII: Conjugated Compounds and Ultraviolet Spectroscopy (8 hrs)** Stability of conjugated dienes: molecular orbital theory, electrophilic addition to conjugated dienes: allyliccarbocation, kinetic versus thermodynamic control of reactions, the Diels-Alder cyclo-addition reaction, characteristics of Diels-Alder reaction, diene polymers: natural
• Explain the mechanism of Diels-Alderreaction and cyclo-addition reaction. • Discuss the properties of diene polymers. • Discuss the theory, instrumentation andapplications of ultraviolet spectra. • Describe the applications of UVspectroscopy in diene. • Discuss the effects of conjugation inorganic molecules. • Discuss the UV spectra of some organiccompounds. • Discuss the applications of UVspectroscopy in structure elucidation of some simple molecules.	and synthetic rubber, structure determination of conjugated dienes: ultraviolet spectroscopy, interpreting ultraviolet spectra: the effect of conjugation, conjugation, color, and the chemistry of vision, applications of UV spectroscopy.
• To explain the naming of coordination compounds based on the revised rules ofIUPAC. • To describe the different types of isomerism that exists in coordination compounds. • To work out the number of isomers for compounds of the type [M(AA)a2b2], [M(AB)3], [Ma4b2], [Ma3b3]	**<u>Inorganic Chemistry</u>** **Unit VIII: Coordination Compounds (5 hrs)** IUPAC nomenclature of coordination compounds including bridged complex, isomerism in coordination complexes: a) conformation isomerism b) ionization isomerism c) hydrate isomerism d) coordination isomerism e) linkage isomerism f) coordination position isomerism g) ligand isomerism h) polymerization isomerism i) geometrical isomerism j) optical isomerism k) valency isomerism.

• To develop a general understanding of basic concepts of valence bond theory and crystal field theory. • To understand the modification needed in simple crystal field theory. • To explain the different parameters which affect the magnitude of crystal field splitting. • To understand the applications of crystal field stabilization energy. • To know the selection rules for electronic transitions. • To understand the concept of hole formalism. To explain the nephelauxetic effect and to understand the role of ligand. • To be familiar with the different tools employed for characterization of coordination compounds including magnetic methods. • To explain the thermodynamic aspects of complexes with an understanding of thermodynamic and kinetic stability, stepwise and overall stability constants.	**Unit IX: Coordination Chemistry (15 hrs)** Bonding, Spectra and Magnetism: Bonding in coordination compounds, valence bond theory, d^2sp^3 hybridization in inner orbital complexes, sp^3d^2 hybridization in inner orbital complexes, sp^3, dsp^2 and dsp^3 hybridization. Crystal field theory: important features, factors affecting the magnitude of Δ, application of crystal field theory. Jahn Tellor distortion, application of crystal field stabilization energies (CFSE). Introduction to molecular orbital theory and ligand field theory, selection rules for electronic transition, hole formalism and nephelauxetic effect. Characterization of coordination compounds by spectroscopic and magnetic methods, thermodynamic and kinetic aspects of metal complexes.

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs

External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Viva-voce**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failedstudent will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment willbe seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will beconducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of thecourse.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions. **Instructional Techniques:** All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student doesnot attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attenda formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Texts for CHM481

1. H. V. Keer, **Principles of the Solid State**, New Age International (P) Ltd., New Delhi, 2002.
2. I. N. Levine, **Quantum Chemistry**, 6th Edition, PHI Learning Pv. Ltd., New Delhi, 2012.
3. S. Glasstone, **Theoretical Chemistry**, 1st Edition (reprinted in 1955), D. Van Nostrand Company, Inc., NewYork, 1944.
4. John McMurry, **Introduction to Organic Chemistry**, Brookes/Cole, 2007.
5. R. T. Morrison & R. N. Boyd, **Organic Chemistry**, Prentice- Hall of India Pvt. Ltd., 2008.
6. S. K. Gautam, S. K. Kalauni, K. R. Sharma, B. R. Poudel & D. Wagle, **Text Book of Chemistry**, Vols 1 & 2,National Book Centre, Kathmandu, 2016.
7. J. D. Lee, **Concise Inorganic Chemistry**, 5th Edition, John Wiley and sons. Inc., 2007.
8. M. R. Pokhrel & B. R. Poudel, **A Textbook of Inorganic Chemistry**, 2ndEdition, National Book Centre, Kathmandu, 2011.

6. References for CHM481

1. S. H. Maron & C. Prutton, **Principles of Physical Chemistry**, Oxford and IBH Publication and Co., 1992.
2. P. Atkins & J. de Paula, **Elements of Physical Chemistry**, 5th Edition, Oxford University Press Inc., New York(Printed in India by Saurabh Printers Pvt. Ltd., New Delhi), 2009.
3. S. Negi & S. C. Anand, **A Textbook of Physical Chemistry**, New Age International Pvt. Ltd., New Delhi, 1999.
4. A. K. Chandra, **Introductory Quantum Chemistry**, 4th Edition, Tata McGrawn-Hill, New Delhi, India, 1994.
5. J. S. H. Pine, **Organic Chemistry**, McGraw Hill International Edition Series, New York, USA, 1987.

6. F. A. Cotton, G. Wilkinson & C. Gaus**, Basic Inorganic Chemistry**, John Wiley & Sons (Asia) Pvt. Ltd., 2007.
7. D. F. Shriver & P. W. Atkins, **Inorganic Chemistry**, W. H. Freeman and Co., London, 1999.
8. B. R. Puri, L. R. Sharma & K. C. Kalia, **Principles of Inorganic Chemistry**, Shoban Lal Nagin Chand and Co.,Delhi, India, 1996.
9. W. U. Malik, G. D. Tuli & R. D. Madan, **Selected Topics in Inorganic Chemistry***,* 8th Revised Edition*,* S. Chandand Company Pvt. Ltd., 2014.
10. J. E. Huheey, Ellen A. Keiter & L. Richard Keiter, **Inorganic Chemistry**, 4th Edition, Addition-Wishley PublishingCompany, 1993.
11. R.M. Silverstein, F.X. Webster, D.J. Kiemle & D.L. Bryce, **Spectrometry Identification of Organic Compounds**,8th Edition, John Wiley and Sons Inc. USA, 2014.
12. G. R. Chatwal & S. K. Anand, **Instrumental Methods of Chemical Analysis**, Himalaya Publishing House, India,2016.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Chemistry XI F.M.: 100
Course No.: CHM 482 P.M.: 45%
Nature of Course: Theory Credit: 4
Level: B. Sc. Number of hours per week: 4
Year: Fourth, Semester: Eighth Teaching Hours: 60

1. Course Description:

The course intends to enable the students to be acquainted with the knowledge of advanced chemistry in all three branches of physical, organic and inorganic chemistry. Students will be familiarized with the reaction dynamics & mechanisms, basics of corrosion & corrosion control, pericyclic reactions, organic synthesis, supramolecular & green chemistry, inorganic reaction mechanism, metal carbonyls and nitrosyls.

2. Course Objectives:

The general objectives of the course are as follows:

- To enable the students to understand the kinetics of collision & transition state theories, chain & polymerization reactions.
- To introduce the basic concepts of corrosion and its control methods.
- To familiarize the students with basic knowledge of pericyclic reactions, organic synthesis, supramolecular & green chemistry.
- To enable the students with basic knowledge of different types of inorganic reactions in coordination complexes and their mechanism.
- To familiarize the students with basic concept of inertness and lability of coordination compounds.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Study the kinetics of the collision theory of unimolecular and bimolecular reactions. • Explain the kinetics of the transition state theory. • Describe the kinetics of some chain reactions of the photochemical decomposition of ozone and reaction between hydrogen & bromine molecules. • Study the kinetic salt effect. • Discuss the kinetics of stepwise and chain polymerizations.	**Physical Chemistry** **Unit I: Reaction Dynamics and Mechanisms (8 hrs)** Kinetics of bimolecular and unimolecular collision reactions, transition state theory, kinetics of some chain reactions (photochemical decomposition of ozone and hydrogen & bromine reaction), primary salt effect, polymerization kinetics.
• Define the term of corrosion. • Describe the important components, types, reactions occur and properties of an electrochemical corrosion cell. • Discuss the overall corrosion cost and importance of corrosion study. • Make a brief discussion on types of corrosion (general, pitting, galvanic, selective leaching, intergranular, environmental cracking, crevice, aqueous, atmospheric, soil & concrete corrosion). • Explain briefly the different corrosion control techniques of metallic materials.	**Unit II: Corrosion and its Control (12 hrs)** Introduction, definition, fundamentals of corrosion cells, cost and importance of corrosion study, types of corrosion: based on corroded surfaces and corrosive environments, brief discussion of corrosion control methods (control of corrosive environments, inhibition, coating, cathodic and anodic polarization techniques).
• Explain the concept of molecular orbitals in organic chemistry. • Describe the mechanism of pericyclic reactions. • Explain the concept of electrocyclic reactions.	**Organic Chemistry** **Unit III: Orbitals and Organic Chemistry: Pericyclic Reactions** **(6 hrs)**

• Discuss the nature of photochemical reactions.	
• Describe the mechanism of cycloaddition reaction with stereochemistry. • Explain the concepts of sigmatropic rearrangements.	Molecular orbitals & pericyclic reactions of conjugated pi system, electrocyclic reactions, stereochemistry of thermal electrocyclic reactions, photochemical electrocyclic reactions, cycloaddition reaction, stereochemistry of cycloadditions, sigmatropic rearrangements, a summary of rules for pericyclic reactions.
• Discuss the modern concepts of organic synthesis. • Explain the concepts of retrosynthesis, synthon, retron and umpolung in organic synthesis. • Describe the process of monofunctioal and bifunctional disconnection approaches in organic synthesis. • Discuss the microwave synthesis of organic compounds. • Describe the importance of protection and deprotection of functional groups in organic synthesis. • Describe the advantages of solid support synthesis over conventional synthesis. • Discuss the importance of combinatorial synthesis of organic compounds.	**Unit IV: Organic Synthesis (8 hrs)** Gradual development of organic synthesis, retrosynthesis, synthon, retron and umpolung, monofunctional disconnection (examples of alcohol, alkene, ketone, carboxylic acid and their derivative, alkane, amine disconnections), bifunctional disconnection, microwave assisted organic synthesis, protection of functional groups, protection of C-H bond, C=C bond, alcoholic-OH, amino group, aldehydes and ketones, carboxylic group, solid support synthesis, combinatorial synthesis, common solid supports, peptide synthesis on solid support.
• Describe the concept of supramolecules, structure and uses in chemistry. • Discuss the cation and anion binding host molecules. • Explain the uses of cation and anion binding host molecules.	**Unit V: Introduction to Supramolecular Chemistry: Host-Guest Chemistry (4 hrs)** Introduction, cation binding host molecules, selectivity of host molecules, few synthetic cation binding host molecules, some uses of cation binding host compounds, anion binding host compounds, neutral molecule trapping host compounds.
• Explain the term green chemistry and green chemistry approaches in organic synthesis. • Discuss the principles of green chemistry. • Discuss about the green reactions and use of green catalyst in organic synthesis. • Explain the advantages of green chemistry approaches in synthesis.	**Unit VI: Green Chemistry (2 hrs)** Introduction, basic principles of green chemistry, need of green chemistry, green catalyst, phase transfer catalyst, green reactions.

• To describe the different types of inorganic reactions in the coordination complexes. • To explain substitution reactions, electron transfer reactions, isomerization and racemization reaction. • To explain the ligand substitution reaction in octahedral complexes. • To describe electrophilic substitution reaction. • To understand the different parameters involved in ligand substitution reactions. • To introduce the concept of acid hydrolysis and base hydrolysis. • To have an insight in the associative and dissociative mechanism of ligand substitutionreaction. • To understand the inertness and lability of coordination compounds in relation to $t2g^x$, eg^y configuration. • To explain ligand substitution reaction in square planar complexes.	**Inorganic Chemistry** **Unit VII: Inorganic Reaction Mechanism (12 hrs)** Broad classification of mechanism of inorganic reactions, ligand substitution reactions in octahedral complexes, nucleophilic (or ligand) substitution reaction (SE reactions), fundamental of ligand substitution reaction, concept of activated complex, labile and inert complexes, acid hydrolysis and base hydrolysis reaction. Mechanism of substitution reaction in octahedral complexes: 1) dissociative (d) unimolecular nucleophilic substitution or S_N^1 mechanism & 2) associative (a) bimolecular nucleophilic substitution or S_N^2 mechanism.
• To apply trans effect in square planar complexes. • To explain the outer sphere and inner spheremechanism for redox reaction..	Lability and inertness of octahedral complexes based on $t2g^x$, e_g^y configuration of metal ion. Ligand substitution in square planar complexes, trans effect. Oxidation reduction reaction in coordination compounds: basic concept of electron transfer or electron exchange reaction, outer sphere (electron transfer mechanism), inner sphere (atom transfer mechanism) or ligand bridged process.
• To describe the nature of □-acceptor ligands of transition metal complexes. • To explain carbonyls and nitrosyls. • To describe the different ways of classifying metalcarbonyls. • To describe the different ways of preparing metalcarbonyls. • To introduce the concept of effective atomic number rule and its application in predicting the stability of metal carbonyls. • To understand the different type of bonds in metalcarbonyls. • To explain the nature of bonding in metal carbonyls. • To understand the scrambling in metal carbonyls. • To be familiar with metal clusters with referenceto metal carbonyls. • To understand the nature of bonding in linearmetal nitrosyls. • To explain the nature of bonding in bent nitrosyls.	**Unit VIII: Transition Metal Complexes with π-Acceptor LigandsCarbonyls, Nitrosyls (8 hrs)** Classification of carbonyls, mononuclear and polynuclear carbonyls, bridged and non bridged carbonyls. Bridged and non bridged carbonyls, general methods of preparation of metal carbonyls, E.A.N rule and its application in metal carbonyls, different types of bonds formed in metal carbonyls, nature of bonding in carbonyl, metal carbonyl scrambling, carbonyl clusters. Metal nitrosyls: linear nitrosyls, metal nitrosyls having NO^- (bentnitrosyls).

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Viva-voce**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment willbe seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will beconducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of thecourse.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions. **Instructional Techniques:** All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a

student doesnot attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attenda formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Texts for CHM 482:

1. S. H. Maron & C. Prutton, **Principles of Physical Chemistry**, Oxford and IBH Publication and Co., 1992.
2. P. Atkins & J. D. Paula, **Atkin's Physical Chemistry**, 10th Edition, Oxford University Press, 2014 (reprinted).
3. R. W. Revie & H. H. Uhlig, *Corrosion and Corrosion Control; an Introduction to Corrosion Science andEngineering*, 4th Edition, John Wiley & Sons, Inc., New York, 2008.
4. J. Bhattarai, **Frontiers of Corrosion Science**, 1st Edition, Kshitiz Publication, Kathmandu, 2010.
5. John McMurry, **Introduction to Organic Chemistry**, Brookes/Cole, 2007.
6. R. T. Morrison & R. N. Boyd, **Organic Chemistry**, Prentice- Hall of India Pvt. Ltd., 2008.
7. S. K. Gautam, S. K. Kalauni, K. R. Sharma, B. R. Poudel & D. Wagle, **Text Book of Chemistry**, Vols 1 & 2,National Book Centre, 2016.
8. J. D. Lee, **Concise Inorganic Chemistry**, 5th Edition, John Wiley and sons. Inc., 2007.
9. F. Basolo & R. Pearson, **Mechanisms of Inorganic Reactions, A Study of Metal Complexes in Solution,** 2ndEdition, Wiley Western Limited.
10. W. U. Malik, G. D. Tuli & R. D. Madan, **Selected Topics in Inorganic Chemistry,** *(*8th Revised Edition)*,* S. Chandand Company Pvt. Ltd., 2014.
11. M. R. Pokhrel & B. R. Poudel, **A Textbook of Inorganic Chemistry**, 2ndEdition, National Book Centre, Kathmandu, 2011.

6. References for CHM 482:

1. J. O'M Bockris, A. K. N. Reddy and M. Gamboa-Aldeco, **Modern Electrochemistry: Fundamentals of Electrodics***,* Vols 2A & 2B, 2nd Edition, Kluwer/Plemum Publishers, New York/London/Moscow, 2000.
2. S. Negi & S. C. Anand, **A Textbook of Physical Chemistry**, New Age International (P) Ltd., New Delhi, 1999.
3. J. S. H. Pine, **Organic Chemistry**, McGraw Hill International Edition Series, New York, USA, 1987.
4. F.A. Cotton, G. Wilkinson & C. Gaus**, Basic Inorganic Chemistry**, John Wiley & Sons (Asia) Pvt. Ltd., 2007.
5. D. F. Shriver & P. W. Atkins, **Inorganic Chemistry**, W. H. Freeman and Co., London, 2014.
6. B. Douglas, D. McDaniel & J. Alexander, **Concepts and Models of Inorganic Chemistry**, Recent edition.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Chemistry Lab F.M.:
Course No.: CHM 483 P.M.:
Nature of Course: Practical Credit: 2
Level: B. Sc. Number of hours per week: 6
Year: Fourth, Semester: Eighth Teaching Hours: 90
(In laboratory course, 1 credit will amount to 3 hours of classes per week)

1. Course Description:

The course intends to enable the students to be skilful in the basic chemical laboratory techniques of physical, organic and inorganic branches of chemistry. Students will be introduced to scientific method of experimentation. They will develop skill on performing an experiment, observing and recording results and judiciously interpreting the results.

2. Course Objectives:

The general objectives of the course are as follows:

- To enable the students to perform experiments on conductometric & potentiometric titrations, buffer solution, spectrophotometric analysis, phase diagram and surface properties.
- To enable the students to perform experiments on spectra analysis, preparation & synthesis, estimation of organic compounds.
- To enable the students to perform the experiment on chemical oxygen demand (COD), volumetric analysis, colorimetric analysis and paper chromatography.

• **Specific Objectives and Course Contents:** Enable the students to find the concentrations of acids in a mixture of strong & weak acid by conductance measurement. • Enable the students to estimate the concentrations of halide ions in a mixture of KCl & KI solution by potential measurement. • Enable the students to prepare acid buffer solution from a mixture of acidic acid & sodium acetate using Henderson's equation and check their values by a pH meter. • Enable the students to estimate the rate constant & half-life time of a oxidation reaction of ethyl alcohol and potassium dichromate in presence of acid. • Enable the students to find out the λmax & ε for ferric-thiocynate complex and also estimate the iron in a locally collected water sample.	**Unit I: Physical Chemistry Practical (30 hrs)** 1. To carry out conductometric titration between a mixture of sulfuric & acetic acids against sodium hydroxide solution. 2. To determine concentrations of Cl^- and I^- in mixture of KCl & KI solution potentiometrically. 3. To prepare standard buffer solutions of 4.0, 4.5, 5.0, 5.5 pH using CH_3COOH and CH_3COONa solutions and measure the pH of solution by a pH-meter. 4. To determine rate constant and half-life time of the oxidation of ethyl alcohol with potassium dichromate in acidic media. 5. To determine the λ_{max} and molar absorbtivity coefficient (ε) for ferric-thiocynate complex and also to determine the concentration of iron in a given sample of water using spectrophotometer. 6. To determine the critical micelle concentration (CMC) of a soap or detergent by surface tension method using a stalagmometer. 7. To determine the freezing point curve of the mixture of naphthalene and biphenyl and also to construct a phase diagram.

• Enable the students to determine the CMC of the locally available soap/detergent powder by surface tension measurement. • Enable the students to estimate the freezing point curve and construct a phase diagram of a mixture of naphthalene & biphenyl.	
• Enable the students to elucidate the structure of some simple organic compounds by spectral Analysis. • Enable the students to synthesize cinnamic acid by Perkin reaction. • Enable the students to prepare pure aspirin in laboratory and to estimate the aspirin in the given 50 gram tablet. • Enable the students to analyze the naturally occurring organic or synthetic compounds from recorded UV spectra. • Enable the students to carry out an experiment on green chemistry. • Enable the students to estimate the ascorbic acid in the given Vitamin-C tablet iodometrically.	**Unit II: Organic Chemistry Practical (30 hrs)** 1. Structure elucidation of some simple organic compounds by spectral Analysis (spectra of simple organic compounds including aliphatic and aromatic hydrocarbon, alcohols, aldehydes, ketones, carboxylic acid, amines, etc will be provided and students are required to interpret the given spectra and find out the structures of organic compounds). 2. Synthesis of cinnamic acid by Perkin reaction 3. Preparation of aspirin. 4. Determination of the amount of aspirin present in the given 150 mg aspirin tablet by indirect titration against the standard HCl. 5. Record and analysis of UV spectra of some naturally occurring organiccompound (quercetin) or synthetic compounds. 6. An experiment on green chemistry. 7. Estimation of ascorbic acid in vitamin C tablet iodometrically.
• Enable students to perform experiment to determine chemical oxygen demand (COD) in water sample. • Enable the students to perform experiment to determine the amount of manganese and magnesium in a mixture. • Enable the students to perform experiment to determine the amount of copper and cadmium in a mixture volumetrically and gravimetrically. • Enable the students to perform experiment to determine the available chlorine in bleaching powder. • Enable the students to perform experiment on spot test analysis of salt mixture containing two cations and two anions.	**Unit III: Inorganic Chemistry Practical (30 hrs)** 1. Determination of chemical oxygen demand (COD) in a given sample of water. 2. Determination of amount of magnesium and manganese in a given mixture solution by EDTA. 3. Determination of amount of copper and cadmium in a mixture volumetrically. 4. Determination of amount of copper and cadmium in a mixture gravimetrically. 5. Determination of available chlorine in bleaching powder by using potassium bromate. 6. Spot test analysis of a given salt mixture (two cations and two anions). 7. Qualitative analysis of Group I cations by thin layer chromatography.

• Enable the students to perform experiment on qualitative analysis of group I cations by thin layer chromatography.	

Note: Before the start of an experiment, the teacher presents a lecture on the details of the experiment including the safety considerations. Each student will perform independently all the experiments prescribed in both practical class and examination. Students should complete all the experiments prescribed.

Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a chemistry practical copy and to keep them neat and properly.

3. Prescribed Texts for CHM473

1. David P. Shoemaker, Carl W. Garland & Joseph W. Nibler, **Experiments in Physical Chemistry,** 5th Edition,McGraw-Hill Book Company, 1989.
2. B. P. Levitt, ed. **Findlay's Practical Physical Chemistry**, Longman, London, 1973. (Latest Edition).
3. J. N. Gurtu & A. Gurtu, **Advanced Physical Chemistry Experiments**, 4th Edition, Pragati Prakashan, 2008.
4. N. M. Khadka, S. D. Gautam & P. N. Yadav, **A Core Experimental Chemistry for B.Sc.**, Heritage Publication,Kathmandu, 2016.
5. B. S. Furniss, A. J. Hannaford, P. W. G. Smith & A. R. Tatchel, **Vogel's Text Book of Practical OrganicChemistry**, 5th Edition, Person Education, 2005.
6. L. Shriner, R. C. Fusion & D. Y. Curtin, **The Systematic Identification of Organic Compounds, A LaboratoryManual**, John Wlley and Sons Inc, New York, 1980. (Latest Edition).
7. N. S. Gnanapragasam & G. Ramamurthy, **Organic Chemistry– Lab Manual,** S. Viswanathan Co., Pvt., India,1998.
8. **Vogel's Text Book of Inorganic Qualitative Analyses**, 4th Edition, ELBS, London, 1974. (Latest Edition).
9. P. N. Yadav, M. R. Pokhrel & S. Shrestha, **Advanced Practical Inorganic Chemistry,** Kshitiz Publication, Kahmandu, 2017.
10. M. K. Sthapit & R. R. Pradhananga, **Experimental Physical Chemistry**, Taleju Prakasan, Kathmandu, 1998.
11. K. N. Ghimire, M. R. Pokhrel & K. P. Bohara**, University Experimental Inorganic Chemistry**, Quest Publication,Kirtipur, Kathmandu, 2008.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Nanoscience — F.M.: 100
Course No.: CHM 484 — P.M.: 45%
Nature of Course: Theory (Interdisciplinary) — Credit: 2
Level: B. Sc. — Number of hours per week: 2
Year: Fourth, Semester: Eighth — Teaching Hours: 60

1. Course Description:

The course intends to enable the students acquainted with the basic knowledge of nanomaterials and their technological applications. Students will be familiar with the fundamentals of nano-science, nanomaterials & fabrication, characterization and applications of nanomaterials.

2. Course Objectives:

The general objectives of the course are as follows:

- To familiarize the students with terminologies used in nano-science and classification of nanomaterials.

- To acquaint the students with basic techniques of nanomaterials synthesis using bottom up and top down approaches.
- To familiarize the students with the uses of imaging microscopic techniques for nanomaterials characterization.
- To acquaint the students with high potential nanomaterials of quantum dots and carbon nanomaterials and their uses.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Define the terms of nano-scale & nano-science. • Describe the history, scope & interdisciplinary nature of nano-science. • Give a brief explanation of the early uses of nanomaterials and nanomaterials in nature. • Describe the classification of nano-materials based on dimension & their properties. • Explain the future challenges & opportunities of nanomaterials.	**UNIT I: Introduction of Nano-science (5 hrs)** Nano-scale, history, scope and interdisciplinary nature of nano-science, early applications of nanomaterials, nanomaterials in nature, classification of nano-structured materials (0D, 1D, 2D & 3D) and their unique properties, future challenges and opportunities of nanomaterials.
• Describe the concept of bottom up and top down approaches for nanomaterials synthesis. • Discuss the different physical vapour ((inert gas condensation, laser ablation, sputter- deposition, electron beam evaporation) & chemical deposition (thermally activated chemical vapour deposition, plasma enhanced chemical vapour deposition) methods, sol-gel process, spray conversion, wet chemical, physical and chemical self- assembly methods for synthesis of nanomaterials using bottom up approach. • Describe different synthesis techniques of mechanical alloying, STM based lithography, dip pen nanolithography, electron beam nanolithography, shockwave consolidation, hot & cold isotatic processes, and spark plasma sintering methods using top down approach.	**UNIT II: Synthesis of Nanomaterials (10 hrs)** Concepts of bottom up and top down approaches, synthesis of nanomaterials using bottom up approaches: physical vapor deposition, chemical vapour deposition processes, sol-gel process, spray conversion process, wet chemical synthesis and self-assembly methods, synthesis of nanomaterials using top down approaches: mechanical alloying, nanolithography (scanning tunneling microscopy based lithography, dip pen nanolithography, electron beam nanolithography), consolidation of nano-powders (shockwave consolidation, hot & cold isotatic processes), spark plasma sintering.

• Explain the fundamental principles behind the formation of images of nanomaterials surface by optical, scanning electron, scanning tunneling, atomic force and transmission electron microscopic techniques. • Discuss the applications of the different microscopic images to characterize the nanomaterials. • Explain the fundamental principle of nano- indentation method and its uses for characterization of nanomaterials.	**UNIT III: Characterization of Nanomaterials (8 hrs)** Fundamental principles of imaging microscopic techniques (optical microscopy, scanning electron microscopy, scanning tunneling microscopy, atomic force microscopy and transmission electron microscopy), uses of OP, SEM, STM, AFM and TEM images to characterize nanomaterials, fundamental principle of nano-indentation technique and its uses to characterize nano-materials.
• Explain the concept of quantum dots (QDs). • Discuss different methods of QDs fabrication and its uses. • Describe different types of carbon nano- tubes, fabrication methods of the different carbon nano-tubes and their uses.	**UNIT IV: Nanomaterials with High Application Potential (7 hrs)** Quantum dots: concept of quantum dots (QDs), methods of quantum dots fabrication (lithographically made QDs, field affects QDs and selfassembled QDs), uses of quantum dots, nano-tubes: carbon nano-materials (carbon black, graphite and graphene, single-walled and multi-walled nano-tubes, fullerene), fabrication of carbon nano-tubes and their uses.

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs

External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Viva-voce**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment willbe seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will beconducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of thecourse.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions. **Instructional Techniques:** All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student doesnot attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attenda formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Text for CHM484

1. B. S. Murthy, P. Shankar, Balvev Raj, B. B. Rath & James Murday. **Textbook of Nanoscience and Nanotechnology**, Series in Metallurgy and Materials Science, Baldev Raj (Ed.), Universities Press Private Hyderabad, India, 2012.
2. C. P. Poole, Jr. & F. J. Owens. **Introduction to Nanotechnology**, Wiley India Limited, 2012.
3. B. B. Neupane, B. Pandey, B. Giri & M. K. Joshi, **A Text Book of Nanoscience and Nanotechnology**, HeritagePublishers & Distributors Pvt. Ltd., Kathmandu, 2016.

6. References for CHM484

1. J. Bhattarai, **Frontiers of Surface Science**, 1st Edition, Kathmandu, 2012.
2. K. K. Chattopadadhya & A. N. Banerjee. **Introduction to Nanoscience and Nanotechnology**, PHI LearningPrivate Limited, New Delhi, 2012.
3. C. N. R. Rao, **Nanoworld: An Introduction to Nanoscience and Nanotechnology**, JNCASR, Bangalore, 2010.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Polymer Science F.M.: 100
Course No.: CHM 485 P.M.: 45%
Nature of Course: Theory (Interdisciplinary) Credit: 2
Level: B. Sc. Number of hours per week: 2
Year: Fourth, Semester: Eighth Teaching Hours: 30

1. Course Description:

The course intends to enable the students acquainted with the basic knowledge of polymer science. Students will be familiar with the fundamentals of polymers, chemistry and techniques of polymerization, analysis and testing of polymers, polymer degradation and polymer processing.

2. Course Objectives:

The general objectives of the course are as follows:

- To familiarize the students with different types of polymerization reactions and polymerization techniques.
- To acquaint the students with different types of polymer characterization techniques as molecular weight determination, spectroscopic, microscopic and thermal analysis.
- To acquaint the students with different types of polymer processing techniques for plastics, elastomerics and fibres.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Explain the basic concept of polymer science. • Discuss the classification of polymers based on origin, structure, mode of synthesis and interparticle forces. • Explain the meaning of natural, synthetic, linear, branched and cross linked polymers. • Describe the addition, condensation and coordination polymers. • Describe elastomers, fibres, thermoplastic and thermosetting polymers.	**UNIT I: Introduction (2 hrs)** Fundamentals of polymer science, classification of polymers on the basis of structure, origin, mode of synthesis and interparticle forces.
• Describe the mechanism and kinetics of free radical, cationic and anionic addition polymerizations. • Describe the mechanism and kinetics of condensation polymerization. • Explain the difference between addition and condensation polymerization. • Describe coordination polymerization with suitable examples. • Describe the process of bulk polymerization, solution polymerization, suspension polymerization and emulsion polymerization.	**UNIT II: Polymerization and Polymerization Techniques (8 hrs)** Basic methods of polymerization and their mechanism: addition, condensation, bulk, suspension, emulsion and solution processes, distinguishing features of addition and condensation polymerization mechanisms, coordination polymerization, kinetics of addition and condensation polymerizations.
• Explain the concept of average molecular weights of polymer. • Explain the terms polydispersity and molecular weight distribution of polymers. • Describe the principle and experimental method for the determination of number average molecular weight of polymers by end group analysis. • Describe the principle and experimental method for determination of average molecular weight of polymers by viscosity measurement.	**UNIT III: Polymer Characterization (10 hrs)** Average molecular weight concepts: number average concept, weight average concept, polydispersity and molecular weight distribution.

• Describe the principle and experimental method for the determination of molecular weight distribution of polymers by gel permeation chromatography. • Discuss briefly the chemical analysis of polymers by mass spectrometry and gas chromatography. • Explain the use of infrared spectroscopy and nuclear magnetic resonance spectroscopy in the analysis of polymers. • Describe the principle and experimental method for the analysis of polymers by x-ray diffraction study, microscopic techniques and thermal analysis.	Measurement of molecular weight: end-group analysis, viscometry, gel permeation chromatography. Analysis and testing of polymer-chemical analysis of polymers, spectroscopic methods, x-ray diffraction study, microscopy, thermal analysis.
• Explain the meaning of polymer processing. • Define the terms plastics, elastomers and fibres. • Explain the purpose of compounding in polymer making processes. • Describe the purpose and process of calendaring, die casting, rotational casting, film casting, injection molding, blow molding, extrusion molding, thermoforming, foaming, reinforcing and fibre spinning in polymer processing.	**UNIT IV: Polymer Processing (8 hrs)** Introduction, plastics, elastomers and fibres. Compounding. Processing techniques: calendaring, die casting, rotational casting, film casting, injection molding, blow molding, extrusion molding, foaming, and reinforcing.
• Describe the application of some inorganic, organic, natural and synthetic polymers.	**UNIT V: Application of Polymers (2 hrs)**

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs

External Evaluation	**Marks**	**Internal Evaluation**	**Weigh tage**	**Marks**	**Viva-voce**	**Weigh tage**	**Mark**
End semester examination		Assignments	20%		Report and Presentation on any topic	50%	
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
	60	Attendance	20%	20	Viva	25%	20
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner

will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failedstudent will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of thecourse.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions. **Instructional Techniques:** All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Text for CHM485

1. F. W. Billmeyer Jr., **Textbook of Polymer Science,** 3rd Edition, Wiley–Interscience Publication, 1984.
2. V. R. Gowariker, N. V. Viswanathan & J. Sreedhar, **Polymer Science**, New Age International (P) Ltd., 2001.
3. G. S. Misra, **Introductory Polymer Chemistry**, New Age International (P) Ltd., 2001.

6. References for CHM485

1. A. L. Gupta, **Polymer Chemistry,** 3rdEdition, PragatiPrakashan, Meerut, India, 2013.
2. M. P. Stevens, **Polymer Chemistry An Introduction**, 3rd Edition, Oxford University Press, 2012.
3. M. S. Bhatnagar, **A Textbook of Polymer Chemistry**, S. Chand and Company Ltd., 2012.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Instrumental Method of Analysis** F.M.: 100
Course No.: CHM 486 P.M.: 45%
Nature of Course: Theory (Interdisciplinary) Credit: 2
Level: B. Sc. Number of hours per week: 2
Year: Fourth, Semester: Eighth Teaching Hours: 30

1. Course Description:

The course intends to enable the students acquainted with the basic knowledge of instrumental methods of analysis. Students will be familiar with the fundamentals of electro-analytical and spectroscopic methods.

2. Course Objectives:

The general objectives of the course are as follows:

- To familiarize the students with different electro-analytical techniques like polarography, electrogravimetry, coulometry and amperometry techniques.
- To acquaint the students with basic principle, instrumentation and applications of ion-selective electrodes.
- To familiarize the students with the basic principles, instrumentations and applications of atomic and molecular spectroscopic techniques.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Brief description of different types of electro-analytical techniques. • Discuss the basic principles, experimental set-up & applications of normal dc polarography. • Explain different techniques of linear sweep oscillographic polarography, pulse polarography, ac polarography and stripping voltammetry. • Describe the basic principle, experimental set-up & applications of electrogravimetric technique. • Explain the basic principle, experimental set-up & applications of constant potential & constant current coulometric titrations. • Explain the basic principles, experimental set-up and applications of different types of amperometric titrations including biamperometric titrations. • Describe the basic principle, types & applications of ion-selective electrodes.	**UNIT I: Electro-analytical Methods (10 hrs)** Introduction, classification of electro-analytical techniques, principle, experimental set-up and applications of polarography, basic principles, instrumentation and applications of electrogravimetry & coulometry, principle, experimental set-up and applications of amperometry techniques, principle, instrumentation and applications of ion selective electrodes.
• Brief introduction of electromagnetic radiation, electromagnetic spectrum, energy levels in both atoms and molecules. • Give a brief account on the interaction of electromagnetic radiation with atoms & molecules. • Describe the classification of different types of spectroscopic techniques. • Explain components and their functions of common spectrometers.	**UNIT II: Spectroscopic Methods (5 hrs)** Electromagnetic radiation and spectrum, energy level in atom and molecule, interaction of electromagnetic radiation with atom and molecule, classification of spectroscopic techniques, spectrometers and their components.

• Explain the flame, electro-thermal, glow discharge, cold-vapour, hydride atomizations. • Explain the basic principles, components of AAS spectrometer and their functions. • Describe the applications of AAS and different spectral & chemical interferences encountered in atomic absorption measurements. • Explain the basic principles involved in flame emissionand plasma emission spectrometry.	**UNIT III: Atomic Spectroscopy (8 hrs)** Introduction, atomization & atomization methods, basic principle of atomic absorption spectrometry (AAS), atomic absorption spectrometer & functions of its components, working of AAS, AAS measurements and applications, emission spectroscopic techniques: basic principles of flame emission spectrometry and plasma emission spectrometry,
• Describe the components & their functions of flameemission and plasma emission spectrometers. • Discuss the applications of the flame & plasmaemission spectroscopic methods.	flame emission and plasma emission spectrometers and functions of their components, applications of flame & plasma emission spectroscopy.
• Give a brief description of electronic spectra of molecules, Franck-Condon principle and electronic transitions in organic as well as in inorganic compounds. • Explain the factors affecting absorption bands. • Describe the components of UV-visible spectrometer and their functions. • Discuss the analytical applications of UV-visible spectroscopy. • Give a brief description of infrared region, molecular vibrations, vibrational frequency & IR absorptionbands. • Describe the components of IR/FTIR spectrometers and their functions. • Discuss the applications of IR/FTIR spectroscopy.	**UNIT IV: Molecular Spectroscopic Methods (7 hrs)** UV-visible spectroscopy: electronic spectra of molecules, Franck-Condon principle, electronic transitions in organic and inorganic compounds, factor affecting absorption bands, UV-visible spectrometer, applications of UV-visible spectroscopy, infrared spectroscopy: infrared region, molecular vibration, vibrational frequencies and IR absorption bands, IR spectrometer, Fourier transform spectrometer, FTIR spectrum and their applications.

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs

External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Viva-voce**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment willbe seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will beconducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of thecourse.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions. **Instructional Techniques:** All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student doesnot attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attenda formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Text for CHM486

1. B. Sivasankar. **Instrumental Methods of Analysis**, 1st Edition, Oxford University Press (Indian edition), NewDelhi, India, 2012.
2. D. A. Skoog, D. M. West, F. J. Holler & S. R. Crouch. **Fundamentals of Analytical Chemistry**, 8th Edition,Books/Cole, Cengage Learning, CA, USA, 2004.

6. References for CHM486

1. H. Kaur. **Instrumental Methods of Chemical Analysis**, 10th Edition, Pragati Prakashan, Meerut, India, 2014.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Mathematical Analysis II** F.M.: 100
Course No.: MTH 481 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Eighth Teaching Hours: 45

(1). Course Description

This course is designed for B. Sc. fourth year a continuation of second year real analysis. The main aim of this course isto provide advanced knowledge of real analysis.

(2). Course Objectives

The general objectives of this course are as follows:

- To enable the students to develop good theoretical background of analysis and its applications.
- To enable the students to take up higher studies in related fields.
- To enable the students to make capable for teaching in some related fields of analysis.

(3). Specific Objectives and Course Contents

Specific Objectives	Contents in Detail
• Define real valued functions, complex valued functions with examples. • Define functions, monotonic functions etc. • Define upper and lower integrals and then Riemann integrable functions withsome examples. • Define vector valued functions defined on subsets of $\mathbf{R}^n$. • Explain some properties of vectors, dot product, vector product etc.	**Unit 0: Review of Basic Concepts** Functions Riemann Integrable Functions Vector valued Functions Vectors
• Define monotonic functions with examples. • State and prove the value of increasing function that lies between left handlimit and right hand limit. • State and prove inverse of strictly increasing function is also strictlyincreasing. • State and prove some other properties of monotonic functions. • Explain partition of a closed interval and define a function of boundedvariation on closed interval. • Give some examples related to theorems. • Define total variation and explain some properties. • Define the theorems based on algebra of total variation. • State and prove additive property of total variation. • Derive the theorem concerning total variation on [a, x] as a function of x. • Prove that the function of bounded variation is as the difference of increasing functions as well as strictly increasing functions. • State and prove some theorems related to continuous function of boundedvariation. • Solve some problems concerning functions of bounded variation.	**Unit 1: Functions of Bounded Variation (6 hours)** Properties of monotonic functions Functions of bounded variation Total variation Additive properties of total variation Total variation as a function of x Functions of bounded variation expressed as the difference of increasing functions Continuous function of bounded variation

• Define Riemann-Stieltjes sum and then Riemann integrable function. • Prove every constant function is R-S integrable. • State and prove linear properties on both the integrand and the integrator. • Prove the R-S integral is additive with respect to the interval of integration. • State and prove the formula for integration by parts. • State and prove the theorem related to change of variable in R-S integral. • State and prove the theorem related to reduction of R-S integral to Riemann integral. • Prove the theorem concerning the step functions as an integrator. • Explain with the help of suitable examples that existence of R-S integrals can be affected by changing the value of function at a single point. • Define a step function and greatest integer function with examples. • State and prove the theorem concerning reduction of R-S integral to a finite sum. • Prove every finite sum can be written as a R-S integral. • Define upper and lower R-S sums. • Mention some properties and prove them. • Define upper and lower integrals with examples. • Establish the relation between upper and lower integrals. • Define Riemann's condition and prove the theorem associated with it. • State and prove comparison theorems.	**Unit 2: The Riemann-Stieltjes Integrals (13 hours)** The definition of Riemann-Stieltjes integrals Linear properties Integration by parts Change of variable in R-S integral Reduction to a Riemann integral Step functions as integrators Reduction of a R-S integral to a finite sum Upper and lower integrals Riemann's condition Comparison theorem
• State and prove some theorems related to integrators of bounded variation. • State and prove sufficient conditions for existence of R-S integrals. • State and prove sufficient conditions for existence of Riemann integrals. • State and prove necessary conditions for existence of R-S integrals.	**Unit 3: The Riemann-Stieltjes Integrals (contd.) (7 hours)** Integrators of bounded variation Sufficient conditions for existence of R-S integrals
• State and prove first mean value theorem for R-S integrals. • State and prove second mean value theorem for R-S integrals. • State and prove the theorems concerning the integral as a function of the interval. • State and prove the second fundamental of integral calculus. • State and prove some theorems concerning R-S integrals depending on a parameter. • State and prove the theorem related to the differentiation under the integral sign. • State some theorems concerning interchanging the order of integration without proof. • Solve some related problems.	Necessary conditions for existence of R-S integrals Mean value theorems for R-S integrals The integral as a function of the interval Second fundamental theorem of integral calculus R-S integrals depending on a parameter Differentiation under the integral sign Interchanging the order of integration

• Define directional derivatives and discuss its particular cases. • Prove that existence of directional derivatives in all direction implies the existence of all partial derivatives but converse is not true. • Discuss an example showing that a function can have a finite directional derivative but may fail to be continuous. • Define total derivative with the help of first order Taylor's formula. • Prove that if a function is differentiable then the directional derivatives exist in all directions. • State and prove differentiability implies continuity. • Show the total derivative can be expressed in terms of partial derivatives. • Discuss how linear functions is expressed in the form of matrix. • Define Jacobian matrix with some examples. • State and prove the chain rule. • State and prove the mean value theorem for differentiable functions. • State a sufficient condition for differentiability without proof. • Give an example showing mixed partial derivatives may not be equal. • Give an example showing mixed partial derivatives may be equal. • State and prove sufficient conditions for equality or inequality of mixed partial derivatives. • State and prove Taylor's formula for functions from **R** to **R**. • Solve some related problems.	**Unit 4: Multivariable Differential Calculus (11 hours)** Directional derivatives Directional derivatives and continuity Total derivative The matrix form of a linear function The Jacobian matrix The chain rule The mean value theorem for differentiable functions A sufficient condition for differentiability A sufficient condition for equality of mixed partial derivatives Taylor's formula for functions from **R** to **R**
• Define an improper integral with examples. • Discuss improper integrals of first and second kind with examples. • Clarify the concept of convergence and divergence of the improper integral of first kind with some examples. • Give the geometrical meaning of the improper integral of first kind for $f \geq 0$. • State and prove Cauchy criterion for the improper integral of first kind. • State and prove comparison test. • State and prove limit comparison tests. Clarify them with examples. • Define absolutely convergent and conditionally convergent integrals of first kind with examples. • Prove that absolute convergence implies convergence.	**Unit 5: Improper Integrals (8 hours)** Classification of improper integrals Convergence and divergence of the improper integral of first kind Cauchy criterion Tests for convergence Absolute and conditional convergence

(4). Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	40
(Details are given in the separate table at the end)		Quizzes	10%	
		Attendance	10%	
		Presentation	10%	
		Term papers	10%	
		Mid-Term exam	40%	
		Group work	10%	
Total External	60	Total Internal	100 %	40
Full Marks 60+40 = 100				

(I). External evaluation

End semester examination: It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Term paper: Term paper must be prepared by using computer in a standard format of technical writing and must contain the required number of pages. It should be prepared and submitted individually. The stipulated time for submission of the paper will be seriously taken as one of the major criteria of the evaluation.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- ☐ Lecture and Discussion
- ☐ Group work and Individual work
- ☐ Self-study
- ☐ Assignments
- ☐ Presentation by Students
- ☐ Term Paper writing
- ☐ Quizzes
- ☐ Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

(5). Prescribed Books and References

1. *Mathematical Analysis* – T. M. Apostol, Narosa Publishing House, 2nd Edition
2. *A Textbook of Mathematical Analysis* – Dr. N. P. Pahari, Sukunda Pustak Bhawan, Kathmandu
3. *Mathematical Analysis* – S. C. Malik and Sabita Arora, New Edition, New Age International Pvt. Ltd. Publishers,New Delhi
4. *Real Analysis* – N. L. Carothers, Cambridge University Press, South Asian Edition

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Advanced Algebra II** F.M.: 100
Course No.: MTH 482 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Eighth Teaching Hours: 45

(1). Course Description

This course of Mathematics is designed to gain the advance knowledge about groups, rings and fields and their skills are used in different fields of general and technical sciences. The course emphasizes both theoretical and applicable aspects of groups, rings and fields.

(2). Course Objectives

The general objectives of this course are as follows:

- To enable the students to gain advance concepts about groups, permutation groups and homomorphism.
- To enable the students to gain advance concept about rings and rings of polynomials.
- To enable the student to gain advance concept about fields.

(3). Specific Objectives and Course Contents

Specific Objectives	Contents in Detail
• Define binary operation and algebraic structure. • Define groups, subgroups and cyclic groups. • To obtain smallest subgroup of a group generated by an element. • To obtain infinite cyclic group isomorphic to a set of integers. • To obtain finite cyclic group of order n isomorphic to **Zn**. • Solve some related problems.	**Unit 1: Groups, Subgroups and Cyclic Groups (6 hours)** Binary Operations and Algebraic Structure Elementary Properties of Cyclic Groups Subgroups of Finite Cyclic Groups Generating Sets and Cayley Digraphs Related Problems
• Define permutation groups and cosets. • Discuss the properties of a group and its image under certain conditions. • State and prove Cayley's Theorem. • Define orbits and cycles of the permutation. • Discuss every permutation of a finite set of product of disjoint cycles. • State and prove some related theorems. • Define direct product of the groups. • Discuss the properties of **Zm × Zn** and **Zmn**.	**Unit 2: Permutations, Cosets and Direct Products (8 hours)** Permutation Groups Cayley's Theorem Orbits, Cycles and Alternating Groups Even and Odd Permutations, Transpositions Cosets and Theorem of Lagrange Direct Products Related Problems
• Define group homomorphism with examples. • State and prove some theorems related to homomorphism. • State and prove some theorems related to factor groups. • State and prove the fundamental theorem of homomorphism. • State and prove first, second and third isomorphism theorems. • Discuss the properties of factor groups of a cyclic. • Discuss about general idea of simple groups. • Solve some related problems.	**Unit 3: Homomorphism, Factor Groups and Automorphism (11 hours)** Homomorphisms Evaluation of Homomorphism Properties of Homomorphism Normal Subgroup Factor Groups Automorphism Factor Group Computations and Simple Group Related Problems
• Define rings and fields with examples. • State and prove some theorems related to ring. • Prove that every field is an integral domain and every finite integral domain is a field. • Define characteristic of a ring. • State and prove little Fermat's theorem. • State and prove Euler's theorem. • Discuss field of quotients of an integral domain.	**Unit 4: Rings (7hours)** Rings and Fields Homomorphism and Isomorphism Integral Domains The Characteristic of a Ring Fermat's and Euler's Theorem The Field of Quotients of an Integral Domain Related Problems

• Solve some related problems.	
• Define rings of a polynomials. • State and prove some related thoerems. • Discuss about division algorithm. • State and prove factor theorem.	**Unit 5: Rings of Polynomials** **(9 hours)** Rings of Polynomials in an Indeterminate Factorization of Polynomials over a Field
• State and prove some theorems related to reducible and irreducible polynomials. • Discuss about ideals and factor rings. • Discuss about prime and maximal ideal. • State and prove some theorems related to prime ideals and maximal ideals. • Solve some related problems.	Irreducible Polynomials Ideals and Factor Rings Prime and Maximal Ideals Prime Field Related Problems
• Define extension fields. • To develop idea of Kronecker's theorem. • Define algebraic and transcendental elements. • Define algebraic number and transcendental number. • Define simple extension. • Solve some related problems.	**Unit 6: Fields** **(4 hours)** Introduction to Extension Field Algebraic and Transcendental Elements Simple Extension Related Problems

(4). Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	
(Details are given in the separate table at the end)		Quizzes	10%	
		Attendance	10%	
		Presentation	10%	40
		Term papers	10%	
		Mid-Term exam	40%	
		Group work	10%	
Total External	60	Total Internal	100 %	40
Full Marks 60+40 = 100				

(I). External evaluation

End semester examination: It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Term paper: Term paper must be prepared by using computer in a standard format of technical writing and must contain the required number of pages. It should be prepared and submitted individually. The stipulated time for submission of the paper will be seriously taken as one of the major criteria of the evaluation.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques isas follows:

- ☐ Lecture and Discussion
- ☐ Group work and Individual work
- ☐ Self-study
- ☐ Assignments
- ☐ Presentation by Students
- ☐ Term Paper writing
- ☐ Quizzes
- ☐ Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

(5). Prescribed Books and References

1. *A First Course in Abstract Algebra*, 7th Edition – John B. Fraleigh, Pearson Publication
2. *Topics in Algebra* – I. N. Herstein, Vikas Publication, India
3. *University Algebra* – N. S. Gopalkrishnan, Orient Longman, India
4. *Modern Algebra* – H. N. Nath, Dikshanta Pustak Prakashan, Kathmandu

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Discrete Mathematics** F.M.: 100
Course No.: MTH 483 P.M.: 45%
Nature of Course: Theory (Elective) Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Eighth Teaching Hours: 45

(1). Course Description

This course aims to enable the student to gain basic knowledge of the various topics of Discrete Mathematics such as algorithms, counting techniques, relations, graphs and trees which are useful in mathematics as well as computer science.

(2). Course Objectives

The general objectives of this course are as follows:

- To enable the students to be familiar with the concept of algorithms whose application arises frequently in computer programming.
- To enable the students to gain the concepts of counting techniques and relations which are also useful in many occasions.
- To enable the students to gain the basic concepts of graph theorem and trees which are equally useful in mathematics and computer science.

(3). Specific Objectives and Course Contents

Specific Objectives	Contents in Detail
After studying this unit, students will be able to • recall the concepts of set theory and functions studied in previous levels for further application. • have the concept of algorithms, their properties and algorithms used for various purposes. • know how does the growth of functions takes place and concepts of big-o notation, big-omega notation and big-theta notation. • know several facts about prime integers.	**Unit 1: Algorithms and Prime Integers (9 hours)** A brief review of sets and functions Algorithms The growth of functions Prime integers
After studying this unit, students will be able to • recall the concepts of permutation and combination studied in previous levels for further application. • know about pigeonhole principle & its generalized form and its application in various problems. • be familiar with recurrence relations, modelling with recurrence relations and the formula for compound interest. • know various techniques of solving linear recurrence. • have the knowledge of generating functions and several useful facts about them.	**Unit 2: Counting Techniques (8 hours)** Review of permutations and combinations The pigeonhole principle and its generalized form Recurrence relations Solving linear recurrence relations Generating functions
After studying this unit students will be able to • be introduced with relations, their kinds and operations on them. • know about n – ary relations, operations on them and their applications. • have the concept of various techniques of representing the relations. • be familiar with closures of various relations and techniques of finding them. • have the concepts of equivalence relation and equivalence classes and various facts about them. • have the concept of partial ordering and various facts about them, representing posets by Hasse diagrams and the concept of hexicographic order.	**Unit 3: Relations (10 hours)** Relations and their properties n – ary relations and their applications Representing relations Closures of relations Equivalence relations Partial ordering

After studying this unit, students will be able to • be introduced with graphs and some models involving the graphs. • to get the knowledge of various terms involved in graph theory and special types of graphs with their properties. • know various techniques of representing graphs and have the concept of graph isomorphism. • have the concepts of connectivity of graphs, paths in graphs and various facts about connectedness. • know about Euler's circuits, Euler's paths, necessary and sufficient conditions for their existence. • have the concept of planar graphs, Euler's formula for a planar graph and related concepts.	**Unit 4: Graphs** **(10 hours)** Graphs and graph models Graph terminology and special types of graphs Representing graphs and graph isomorphism Connectivity Euler and Hamilton paths Planar graphs
After studying this unit, students will be able to • have the concept of tree as a special undirected graph, condition for its existence, rooted tree & various facts about it, trees as some models and various properties of trees. • know about some applications of trees. • know about tree transversals, their types and methods for constructing them. • have an introduction with spanning tree, various facts about it, various techniques for finding it. • have an introduction with minimum spanning tree and Prim's algorithm for finding it.	**Unit 5: Trees** **(11 hours)** 5.1 Introduction to trees Application of trees Tree transversals Spanning trees Minimum spanning tree

(4). Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	40
(Details are given in the separate table at the end)		Quizzes	10%	
		Attendance	10%	
		Presentation	10%	
		Term papers	10%	
		Mid-Term exam	40%	
		Group work	10%	
Total External	60	Total Internal	100 %	40
Full Marks 60+40 = 100				

(I). External evaluation

End semester examination: It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Term paper: Term paper must be prepared by using computer in a standard format of technical writing and must contain the required number of pages. It should be prepared and submitted individually. The stipulated time for submission of the paper will be seriously taken as one of the major criteria of the evaluation.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroomdiscussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques isas follows:

- ☐ Lecture and Discussion
- ☐ Group work and Individual work
- ☐ Self-study
- ☐ Assignments
- ☐ Presentation by Students
- ☐ Term Paper writing
- ☐ Quizzes
- ☐ Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

(5). Prescribed Books and References

1. Kenneth H. Rosen, *Discrete Mathematics and Its Applications* (special Indian edition), Tata McGraw Hill PublishingCompany Ltd., New Delhi
2. Joe L. Mott, Abraham Kandel, Theodore P. Baker, *Discrete Mathematics for Computer Scientists and Mathematicians*, Prentice Hall of India Pvt. Ltd., New Delhi

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Linear Programming** F.M.: 50
Course No.: MTH 484 P.M.: 45%
Nature of Course: Theory Credit: 2
Level: B. Sc. Number of hours per week: 1.5
Year: Fourth, Semester: Eighth Teaching Hours: 30

(1). Course Description

This course is designed for B. Sc. four years level. The main aim of this course is to provide basic knowledge of linearprogramming.

(2). Course Objectives

The general objectives of this course are as follows:

- ☐ To enable the students to develop good theoretical background of linear programming and its applications.
- ☐ To enable the students to know about LPP and duality.
- ☐ To enable the students to apply the LPP on real field.

(3). Specific Objectives and Course Contents

Specific Objectives	Contents in Detail
• Define Euclidean space $\mathbf{E}^n$ and some algebraic operations. • Define linearly dependent and independent vectors with examples. • Define a basis with examples. • Prove if any vector $\mathbf{a}_j$ for which $\alpha_i \neq 0$ is removed from the set $\mathbf{a}1, \mathbf{a}2, \ldots \mathbf{a}_r$ and $\mathbf{b}$ is added to this set, the new collection of r vectors is a basis for $\mathbf{E}^n$. • Define a vector space and its sub spaces with some examples. • Define the rank of m × n matrix with examples. • State and prove Cramer's rule for finding the solution to a system of nequations in n unknowns. • Define basic solution and degenerate basic solution with examples. • State and prove a necessary and sufficient condition for the existence and non-degeneracy of all possible basic solution of $A\mathbf{x} = \mathbf{b}$. • Define a line segment joining two points and define hyper planes. • Discuss some properties of hyper planes. • Define a convex set and extreme point with examples. • Prove a hyper plane in a convex set. • Prove open and closed half spaces and convex sets. • Prove the intersection of two convex sets is also convex. • Prove the intersection of a finite number of hyper planes or half spaces or ofboth in a convex set. • Define convex combination and prove the set of all convex combinations(polyhedron) of a finite number of points in a convex set. • Define supporting hyper plane and state the theorems related to convex setsand hyper planes without proof. • Write any point inside a triangle as a convex combination of the vertices. • Define a cone and prove a cone is a convex cone if it is a convex set. • Define a cone generated by a set of points and prove the cone generated by a convex set is a convex cone.	**Unit 1: Mathematical Background (4 hours)** Vectors and Euclidean spaces Linear dependence Bases Vector spaces and sub spaces Rank Simultaneous linear equations Basic solutions Lines and hyper planes Convex sets Convex sets and hyper planes Convex cones

• Define linear programming and some basic terms associated with LP with examples. • State general form of LPP, canonical form and standard form of an LPP. • Solve some LPP of two variables by graphical method. • Solve some LPP of two variables by cost line approach. • Define slack and surplus variables. • Prove that different forms of an LPP are equivalent. • Discuss the limitations of LP.	**Unit 2: LP Models** **(6 hours)** Linear Programming Two variable LP model Graphical solution method Cost line approach Slack and surplus variables Equivalency of different forms of an LPP Limitations of LP
• Define basic feasible solution. • State and prove the theorem concerning reduction of feasible solution into a basic feasible solution. • Discuss the theory related to improvement of a basic feasible solution. • Prove that if an LPP has at least one feasible solution, then it has at least one basic feasible solution. • Prove that if an LPP has an optimal solution, then at least one feasible solution must be an optimal one. • Discuss the theory related to unbounded solutions of an LPP. • Explain the optimality condition. • Discuss the relation of extreme points and basic feasible solution.	**Unit 3: Theory of Simplex Method** **(10 hours)** Basic feasible solutions Reduction of any feasible solution into a basic feasible solution Improving a basic feasible solution Unbounded solutions Optimality condition Extreme points and basic feasible solutions Selection of the vector to enter the basis
• Discuss how we select the vector to enter the basis. • State and degeneracy and discuss the process of breaking ties. • Solve some problems using big M method and two phase method. • Solve related problems.	Degeneracy and breaking ties Big M-method and two-phase method Tableau formate for simplex computations
• Discuss alternative formulation of an LPP. • Define dual of an LPP with examples. • State and prove that the dual of the dual is primal. • State and prove fundamental properties of dual problems. • Clarify the other formulation of dual problems. • Using dual, solve some linear programming problems. • Prove that if i^{th} constraint in the primal is an equality, then the i^{th} dual variable is unrestricted in sign. • Prove that if some variable x_j in the primal is unrestricted in sign, then the j^{th} constraint of the dual problem will a strict equality. • State and prove the complimentary slackness properties. • Prove that if the primal has an unbounded solution, the dual has no feasible solution. • Discuss the dual simplex algorithm. • Solve some related problems.	**Unit 4: Duality Theory** **(6 hours)** Alternative formulation of LPP Dual linear programming problems Fundamental properties of dual problems Other formulations of dual problems Complimentary slackness Unbounded solution in the primal The dual simplex algorithm
• Define transportation problem and write the LP model of transportation problem. • Define assignment problem and write the LP model of assignment problem. • Define diet problem and write the LP model of diet problem. • Define scheduling problem and write the LP model of scheduling problem. • Define production planning problem and write the LP model of production planning problem. • Discuss the maximal flow in the network and formulate it in LP model. • Describe minimum cost flow problem and formulate it in LP model. • Solve related problems.	**Unit 5: Applications of LP** **(4 hours)** LP formulations of some LPP Transportation problem Assignment problem Diet problem Scheduling problem Production planning Maximal flow in network Minimum cost flow problem

(4). Evaluation System:

Undergraduate Programs

External Evaluation	Marks	Internal Evaluation	Weightage	Marks
End semester examination	30	Assignments	10%	
(Details are given in the separate table at the end)		Quizzes	10%	
		Attendance	10%	
		Presentation	10%	20
		Term papers	10%	
		Mid-Term exam	40%	
		Group work	10%	
Total External	30	Total Internal	100 %	20
Full Marks 30+20 = 50				

(I). External evaluation

End semester examination: It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Term paper: Term paper must be prepared by using computer in a standard format of technical writing and must contain the required number of pages. It should be prepared and submitted individually. The stipulated time for submission of the paper will be seriously taken as one of the major criteria of the evaluation.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- ☐ Lecture and Discussion
- ☐ Group work and Individual work
- ☐ Self-study
- ☐ Assignments
- ☐ Presentation by Students
- ☐ Term Paper writing
- ☐ Quizzes
- ☐ Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

(5). Prescribed Books and References

1. *Linear Programming* – G. Hadley, Narosa Publishing House, New Delhi
2. *Linear Programming* – Dr. Bhupendra Singh, Pragati Prakashan, Meerut
3. *An Introduction to Linear Programming* – M. P. Upadhyaya, Sukunda Pustak Bhawan, Kathmandu.