Far Western University
Mahendranagar, Kanchanpur
Faculty of Science and Technology

B. Sc. Sixth Semester Physical Group

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Environmental Engineering** | Credit: **3**

Course Code: **ENV 361** | Number of hours per week: **3**

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

Year: **Third** | Semester: **Sixth**

Objectives

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

- Understand the fundamentals of environmental engineering
- Acquaint with air and water pollution, pollutants and their classification, sources and effects
- Understand air, noise, water and solid waste pollution control technology
- Understand the fundamentals of water pollution, characteristics of wastewater and treatment of wastewater
- Understand the basics of landfill sites (design and operation)

Specific Objectives	**Contents**
• Understand the fundamentals of environmental engineering	**Unit I: Introduction to Environmental Engineering (5 Hrs*)*** Definitions: environment, engineering and environmental engineering; Scope and areas of application of environmental engineering; Units of measurement: base SI units, derived SI units, units outside SI system; Measurement of environmental pollution: air/water pollutant concentration measurement units, conversion of measurement units
• Acquaint with air pollution, air pollutants and their classification, sources and effects • Understand air pollution control technology • Know basics of noise	**Unit II: Air and Noise Pollution Control (10 Hrs)** Sources and types of air pollutants: definition of air pollution, classification of air pollutants, sources of air pollutants; Effects of air pollutants; Environmental standards for air quality: Air Quality Standards (AQS), emission standards; Transport and diffusion of air pollutants: source characteristics, downwind distance,

pollution and control options	wind speed and direction, atmospheric stability; Introduction of air pollution control technology: control of gaseous pollutants, control of particulate pollutants, control of mobile source/automobile emissions; Positive Crankcase Ventilation (PCV) system; Adsoprtion Canisters; Catalytic converters Noise Pollution Control: Sound vis-a-vis Noise; Typical sources of noise; Quantification of sound in terms of SPL and PWL; Typical noise levels at different places and effects of noise; Noise control options
• Get fundamentals of water quality analysis • Understand raw water treatment technology and monitoring of water quality	**Unit III: Water Supply and Treatments (10 Hrs)** Sources of Water Supply; Impurities in water: states of solution impurities; Water quality analysis: types of sampling (grab, composite), types of quantitative analysis (gravimetric analysis, volumetric analysis, colorimetry, physical methods/nephelometry); Engineered systems for water purification; Raw water treatment technology: surface water treatment technology, groundwater treatment technology; Monitoring of water quality: water quality parameters and standards (in-stream standards, potable water standards)
• Understand the fundamentals of water pollution and characteristics of wastewater • Understand the basics of wastewater treatment technology	**Unit IV: Water Pollution Control and Wastewater Treatment (10 Hrs)** Sources of Wastewater: Point sources and Non-point Sources, Water pollutants and their sources; Environmental pollution caused by untreated wastewater; Characteristics of wastewater: characteristics of domestic/municipal WW, characteristics of industrial WW; Characteristics of WW sewerage system: Types of wastewater sewerage system; Wastewater Treatment Technology: Primary treatment, Secondary (Biological) treatment, Advanced treatment; Effluent Standards: Definition, Types; Design and criteria of constructed wetlands
• Acquaint with resource recovery from solid waste	**Unit V: Solid Waste Management (10 Hrs)**

(material, energy) • Understand the basics of landfill sites (design and operation)	Concept of Integrated SW Management (ISWM): hierarchy of waste management; Collection, transfer, disposal of SW: types of collection system, inter-route transfer, final disposal and sanitary landfill, site selection, site preparation; Introduction to resource recovery: material recovery, recovery of biological conversion products, recovery of thermal conversion products, recovery of energy from conversion products; Landfill sites: design and operation aspect of landfill sites; Overview of SW Management in Nepal

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Environmental Engineering PR**	Credit: **1**
Course Code: **ENV 361**	Number of hours per week: **3**
Nature of the Course: **Practical (Core Course)**	Total hours: **45**
Year: **Third**	Semester: **Sixth**

Practical Session for EE

1. Water quality analysis of wastewater (pH, EC, TSS, COD, BOD, Ammonia, TKN, TotalPhosphorus, Coliform bacteria, Relevant heavy metals)
    a. Municipal wastewater
    b. Industrial wastewater
2. Analysis of solid waste: household, commercial and municipal
    a. Physical – mass, volume, density, moisture content, physical classification, calorificvalue
3. Analysis of leachate from landfill sites (Temperature, pH, EC, Ammonia, BOD, COD,Relevant heavy metals)
4. Determination of TSP and PM_{10} Concentration in Ambient Air
5. Measurement and comparison of noise level (equivalent, percentile) in residential, public andwork places
6. Field Visits
    a. Field visit to water and wastewater treatment plants for water treatment and wastewater treatment technologies (*Students are required to submit field visit reportindividually*)
    b. Field visit to landfill sites for solid waste management technologies (*Students arerequired to submit field visit report individually*)
    c. Field visit to industries for air pollution control technologies (*Students are required tosubmit field visit report individually*)

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Energy and Environment** Credit: **3**

Course Code: **ENV 362** Number of hours per week: **3**

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

Year: **Third** Semester: **Six**

Level: **B.Sc.**

Course Objectives

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

- Understand the basics of linkages between energy and environment
- Acquire knowledge on various types of renewable energy and technologies to harness the respective energies
- Acquire knowledge on various types of non-renewable energy and environmental impacts of non-renewable energy consumption
- Understand approaches to use energy sustainably and efficiently
- Understand contemporary issues in energy policy
- Take insights on organizations/institutions in energy sector

Objectives	**Units, Contents and Lecture Hours**
• Understand the basics of linkages between energy and environment	**Unit I: Introduction (6 Hrs)** Concept of energy and energy units; Renewable and non-renewable energy sources; Energy consumption and environmental impacts; Environmental concerns in energy development; Status and issues of energy resources in Nepalese context
• Acquire knowledge on classification, production and consumption of energy	**Unit II: Classification, production and consumption of energy (5 Hrs)** Energy classification: Renewable and non-renewable; Traditional, commercial and alternative energy resources; Production and consumption of energy: Global, regional and national scenario;
• Acquire knowledge on various types of renewable energy and technologies to harness the respective energies	**Unit III: Renewable Energy and Technologies (12 Hrs)** Renewable energy technologies, share of renewable energy in energy use; Hydropower energy: hydroelectricity in Nepal, environmental impacts; Solar energy: solar thermal energy, solar photo voltaic, solar energy in Nepal; Bio-energy:

	biogas production and use in Nepal, charcoal, bio-briquettes; Energy from waste (Waste to energy, W2E); Ocean energy (OTEC, wave energy, tidal wave); Wind energy; Hydrogen energy and fuel cells; Geothermal energy;
• Acquire knowledge on various types of non-renewable energy and environmental impacts of non-renewable energy consumption	**Unit IV: Non-renewable Energy (7 Hrs)** Non-renewable energy: conventional fossil fuels (coal, petroleum, natural gas) and non-conventional fossil fuels (oil shale, natural gas hydrates in marine sediments) ; Nuclear energy; Environmental impacts of non-renewable energy consumption
• Understand approaches to use energy sustainably and efficiently	**Unit V: Conservation of Energy Resources (5 Hrs)** Introduction to sustainable energy; Sustainability challenge: energy, climate and environment; Energy efficiency: industry, transportation, commercial and residential buildings;
• Understand contemporary issues in energy policy • Take insights on organizations/institutions in energy sector	**Unit VI: Energy Economics and Policy (10 Hrs)** Prospects of green technology and financing; Energy markets and strategy Contemporary issues in energy policy; Energy and Society: energy issues in developing countries; Climate change and the quest for green energy; Decarbonizing energy sector: challenges and opportunities Organizations/institutions working on energy development, Policy directives**,** Scope and challenges of renewable energy applications in Nepal

References:

1. Boyle, G. (2008). (Ed.). Renewable energy: power for sustainable future. OxfordUniversity Press, New York.
2. Hinrich, R.A. (1996). Energy: its use and the environment. Sanders College Publishing, Philadelphia.
3. Kothari, D.P., Singal, K.C., and Ranjan, R. (2009). Renewable energy sources andenergy technology. PHI Learning Pvt. Ltd., New Delhi.

4. Masters, G.M. (1974). Introduction to environmental science and technology. Wiley,New York.
5. Miller, Jr. G. T. and Spoolman, S.E. (2009). Living in the Environment: Concepts, Connections, and Solutions, 16th Edition. Brooks/Cole, CengageLearning.
6. Nalini, K.S. (1993). Environmental Resources and Management. AnmolPublishers.
7. Ristinin, R.A. and Kraushaar, J.J. (2006). Energy and Environment. JohnWiley and Sons, Inc., New York.
8. Ristinin, R.A. and Kraushaar, J.J. (2006). Energy and environment. John Wiley and Sons Inc., New York.
9. UNDP/NPC. (1995). Prospective energy plan for Nepal. Perspective Energy Plan Project United Nations Development Programme and National planning Commission, Kathmandu.
10. WECS, 2010. Energy Synposis Report, Water and Energy Commission Secretariat, GoN, Kathmandu.
11. WECS. (1995). Alternative energy technology- overview and assessment. Water and Energy Commission Secretariat, GoN, Kathmandu.
12. WECS. (2006). Energy synopsis report. Water and Energy Commission Secretariat, GoN, Kathmandu.

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Research Methodology I**
Course No.: **RSM 361**
Nature of the Course: **Theory**
Year: **Third**, Semester**: Sixth**
Level: **Undergraduate (B.Sc.)**

Credit: **3**
Number of hours per week: **3**
Total hours: **45**

Course Description

The course intends to enable the students to be acquainted with the basic concepts of Research Methodology. Students will be familiarized with the fundamentals of Research and its methods, Research design, Types of researches, Ethical standards, Proposal writing, etc.

Course Objectives

At the end of this course the students should be able:

- to understand the importance of ethical standards and methods of scientific research
- to acquire sufficient basic knowledge in research methodology
- to apply this knowledge base for conducting researches
- to prepare research proposals

Course Contents

1. Introduction to Research: Objectives, Types, Approaches and significance of research and researchmethodology, Ethical issues and plagiarism [7]
2. Defining the Research Problem: Selecting and defining a problem, Necessity and techniques involved indefining a problem [4]
3. Research Design: Important features of research design, Concepts, Different research designs,Theoretical and experimental designs [7]
4. Design of Sample Surveys: Sampling errors, Sample survey and census survey, Types of samplingdesign [3]
5. Measurement and Scaling: Quantitative and qualitative data, Measurement scales, Sources of error,Measurement tools and scaling [7]
6. Data Collection and Preparation: Experimental and survey data, Primary and secondary data, Selectionmethods, Process of data preparation, Missing values and outliers, Statistics in research [9]
7. Statistical Analysis: Central tendency, Dispersion, Skewness, Correlations [8]

References and suggested readings

C. R. Kothari and G. Garg, Research Methodology: Methods and Techniques (Third edition), New Age International Publishers, India (reprint 2017)

Murray R. Spiegel and Larry J. Stephens,Statistics (Schaum's Outline Series) 4th edition, Tata McGraw-HillPub., India (2010)

P.K.Jha, D. D. Shakya, S. D. Joshi, R.P. Chaudhary and S.R. Shakya (eds.), Research Methods and Practice,Buddha Academic Publishers and Distributors, Kathmandu, Nepal (2004)

Ranjana Gupta and Deb P.Pandey, Research Methodology: Fundamentals and Practice, RatnaPustakBhandar,Kathmandu, Nepal (2007)

FAR WESTERN UNIVERSITY

PHYSICS CURRICULUM (B.Sc.)

SIXTH SEMESTER

SEMESTER	COURSES	CH
SIXTH SEMESTER (Two-Major)	**Core Course:** *any one discipline (Physics or...)*	-
	PHY321: Atomic, Nuclear & Particle Physics	3
	PHY322: Physics Lab	1
	PHY322: Relativity	3
Total Credit		**7**

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Atomic, Nuclear & Particle Physics** Credit: **3**
Course Code: **PHY 361** Number of hours per week: **3**
Nature of the Course: **Theory** Total hours: **45**
Year: **Third**, Semester**: 6th**
Level: **B.Sc.**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of atomic, nuclear and particle physics. Students will be familiarized with the fundamentals of atomic, sub-atomic and nuclear structures, their model and properties, interaction modes and a few experimental techniques.

2. Course Objectives

At the end of this course the students should be able:

- to acquire sufficient basic knowledge in atomic, nuclear and particle physics
- to apply this knowledge base for studying major courses in physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Describe Rutherford experiment and discuss its importance to understand atoms and nuclei • Analyse the spectra of H-atom and explain Bohr's idea • Describe Frank-Hertz experiment and itsresult, interpret about its result • Discuss Sommerfeld modification regarding the electronic orbits and its behavior withnucleus.	**Unit I: Atomic Structure (5)** Rutherford scattering: conclusion and limitations, the Bohr's atom, energy level diagram and spectra of hydrogen atom, Frank-Hertz experiment and limitations of Bohr's model, the Sommerfeld atom
• Describe the meaning of spin of an electron inmodern physics • Explain the experimental detail and the hypothesis of Stern-Gerlach experiment,interpret its result. • Explain the reason behind the introduction ofPauli Exclusion principal • Describe the concept of space quantization and intrinsic angular momentum and hence thevector atom model • Derive the expression for velocity, radius, kinetic energy, potential energy and hence thetotal energy of an electron in an atom • Explain the meaning of spin-orbit coupling and hence describe the importance of finestructure constant in the atomic spectra	**Unit II: Many Electron Atom (5)** Electron spin, Stern-Gerlach experiment, Pauli's exclusion principle, shells and subshells of electrons, vector atom model, LS coupling and s, p, d, f notation
	Unit III: Atomic Spectra (4) Fine structures of H, Na, He and Hg, Paschen-Back

• Discuss fine structures of given atoms (explainit in the aspect of spin-orbit coupling) • Discuss the effect on such atomic spectra whenuniform magnetic field (weak to strong) is applied. • Work out for the expression for change in energy level (or shift / split) in the presence ofmagnetic field	effect, normal and anomalous Zeeman effect
• Describe a fundamental properties ofelectromagnetic waves • Explain how e.m. wave interact with matter • Explain low (photoelectric) to high energy (Compton, pair production) interaction of e.m.waves with matter	**Unit IV: Particle properties of waves (4)** Electromagnetic waves and its interaction with matter,photoelectric effect, Compton scattering and pair production,
□Describe X-ray spectra and explain itspeculiarities over atomic spectra □Discuss X-ray diffraction and its implications □Describe Moseley's law and use it to solve problems.	**Unit V: X-ray Spectrum (3)** Characteristic X-ray, X-ray diffraction, fine structure ofX-ray transitions, Moseley's law and its application
□Explain several hypothesis regarding the nucleus formation □Discuss the observed properties of nuclei and draw a conclusion regarding its mass, charge, density, magnetic and electrical properties □Draw nuclear stability curve and justify it in terms of binding energy of a nuclei □Discuss the meson theory of nuclear forces	**Unit VI: Nuclear Structure (5)** Proton-electron and proton-neutron hypothesis, nuclear composition and its properties (mass, charge, density, magnetic and electric properties), nuclear stability and binding energy, Meson theory of nuclear forces

□Formulate the laws of successive radioactive disintegration with the explanation of half and mean life □Describe all four natural radioactive series □Explain the origin, interaction and propertiesof alpha particle □Discuss neutrino hypothesis in order to explain the reason behind □-decay.	**Unit VII: Nuclear Transformations (6)** Law of successive radioactive disintegration, half-life, mean life, natural radioactive series, alpha, beta and gamma ray spectra, absorption of α particles, its range and stopping power, theory of α decay, neutrino hypothesis of β-decay
□Describe all seven conservation laws for elementary particles and use it to solve problem □Describe the reason behind the generation of quark and leptons in the standard model □Explain the properties of meson, baryon, quarks and leptons □Discuss how quark and lepton interacts □Elaborate standard model of particle physics	**Unit VIII: Elementary Particles (7)** Conservation laws: lepton number, baryon number, parity, charge conjugation, Isospin, Strangeness and Hypercharge, Parity violation: examples and explanation, quark and lepton: generations and properties, Baryon and Meson: properties and examples, Interaction of quarks and leptons, Standard Model of particle physics: matter sector
□Explain the principal, working and limitations of particle detectors and its use in understanding behavior of fundamental particles. □Explain the principal, working and limitations of particle accelerators and its use to understand character, interaction and behavior of fundamental and composite particles. □Describe the motives and achievements of LHC project at CERN, Geneva	**Unit XI: Particle Detectors and Accelerators (6)** G. M. counter, bubble chamber, Cerenkov detectors, linear accelerator, cyclotron, synchrocyclotron, betatron, the LHC project

Text and Reference Books

1. *Beiser A., Mahajan S. and Choudhury S. R.* - **Concepts of Modern Physics**, Tata McGrawHill Education, New Delhi (2011)
2. *Marmier, P. and Sheldon E.* - **Physics of Nuclei and Particles**, Academic Press New YorkLondon (1970)
3. *Murugeshan R. and Sivaprasad K.* - **Modern Physics**, S. Chand and Company, New Delhi(2012)
4. *Blatt F. J.* - **Modern Physics**, McGraw Hill International (1992)
5. *Wahr M. R., Richard J. A. and Adir T. W.* - **Physics of the Atom**, Addison Wesley (1984)
6. *Leighton R. B.* - **Principles of Modern Physics**, McGraw-Hill Education (1959)

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Atomic, Nuclear & Particle Physics PR** Credit: **1**
Course No.: **PHY 361** Number of hours per week: **3**
Nature of the Course: **Practical** Total hours: **45**
Year: **Third**, Semester**: 6th**
Level: **B.Sc.**

1. Course Description
The course intends to enable the students to be acquainted with the basic concepts of generalexperiments.

2. Course Objectives
At the end of this course the students should be able:

- To provide students with skill and knowledge in the experimental methods.
- To make them able to apply knowledge to practical applications.
- To make them capable of presenting their results/conclusions in a logical order.

3. Specific Objectives and Contents

Specific Objectives	Contents
' Understand how charge (e) of an electronis determined by using Millikan's oil drop method. ' Understand how charge (e) of an electron is determined by using Thomson's method. ' Develop the skill to analyse the data and perform error analysis ' Understand the resolution time, dead time,recovery time and hence efficiency of G.M. counter that you have in the laboratory. ' Compare the platue curve inside the lab (almost no cosmic radiation) and outside (terrestrial and cosmic radiation) the lab ' Understanding the radioactive emission	**Unit I: General Lab (45)** **1.** To determine the charge (e) of an electron by using Millikan's oil drop method. **2.** To determine the specific charge of an electron (e/m) by Thomson's method. **3.** Perform the experiment 1-2 and compile a dataset of specific charge of an electron. Show the histogram and calculate the standard deviation and standard error. Interpret the result. **4.** To study the characteristics of Geiger Muller (G.M.)counter and find its reliability. **5.** To study the platue region of Geiger Muller (G.M.)counter in and outside the laboratory. **6.** Study the variation in the natural background count along all possible directions (east, west, north and

from natural background. • Develop the skill to analyse the data andperform error analysis • Understanding the ionizing and penetrating power of β-particles in air and in Al absorbers using a G.M. counter. • Understanding penetrating power of by determining low value of absorption coefficient of □-rays in Al, Cu and brass absorber using a G.M. counter. • Study the properties of gamma rays as electromagnetic radiation. • Develop the skill to analyse the data andperform error analysis	south) using Geiger Muller counter. **7.** Perform the experiment 6-8 and compile a dataset of count rate at a particular operating voltage. Show the histogram and calculate the standard deviation and standard error. Interpret the result. **8.** To determine the linear absorption coefficient of β-particles in air and in Al absorbers using a G.M. counter. **9.** To determine the linear absorption coefficient of □- rays in Al, Cu and brass absorber using a G.M. counter. **10.** Verify inverse square law using a standard □-ray source and G.M. counter. **11.** Perform the experiment 10-11 and compile a dataset of count rate at a particular operating voltage. Show the histogram and calculate the standard deviation and standard error. Interpret the result.

Note: Students have to perform at least 6 experiments in 45 working hours. 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 separate sheet, and to keep them neat and properly filed.

The practical exam will be graded on the basis of the following marking scheme:

In-Semester Evaluation	20%
Final Exam Written	60%
Final Exam Oral	20%

Text Books:

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)
2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)
3. Shukla, P. K. and Srivastava, A. - **Practical Physics**, New Age International (P) Limited,Publishers (2006)

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Relativity**
Course Code: **PHY 362**
Nature of the Course: **Theory**
Year: **Third**, Semester**: Sixth**
Level: **B.Sc.**

Credit: **3**
Number of hours per week: **3**
Total hours: **45**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts theory of relativity. Students will be familiarized with the fundamentals of special theory of relativity and a brief introduction of general relativity.

2. Course Objectives

At the end of this course the students should be able:

- to acquire sufficient basic knowledge in relativistic mechanics.
- to apply this knowledge base for studying major courses in physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Understand the need of special relativitytheory • Understanding about much debated Michelson-Morely experiment and itsinterpretation	**Unit I: Special Relativity (6)** Frame of reference, postulates of special relativity, Ether hypothesis, Michelson-Morely experiments: it result, achievements and limitations
• Understanding the difference between the Newtonian frame of reference and frame ofreference used for relativity • The knowledge of transformation scheme between Galilian and Lorentz and its use to deal the fundamental quantities (length, massand time)	**Unit II: Lorentz Transformation (6)** Galiliean transformation, Lorentz transformation, inverse Lorentz transformation, addition of velocity, relativistic velocity transformation
• Developing the idea of space-time coordinatesystem and its transformation • Knowledge about the time interval in space-time co-ordinate system • Discuss the knowledge about the past, presentand future using light cone • Understanding of space-like, time-like andlight-like interval	**Unit III: Space time (7)** Space time and Lorentz transformation, space time interval between events, past and future light cone in space time, time-like interval, space-like interval, light- like interval, constancy of speed of light
• Use inverse Lorentz transformation to find the	**Unit IV: Time dilation & Length Contraction (8)** Proper time, time dilation, its example in real life and in
expressions for time dilation and lengthcontraction • Use these expressions to solve relativistic realproblems • Understanding of transverse and longitudinalDoppler effect light • Understanding the bridging between electricityand magnetism by the relativity	experiments, ultimate speed limit, Doppler effect in sound, transverse and longitudinal Doppler effect in light, the expanding Universe, simultaneity, twin paradox: examples, Proper length, length contraction, its example in real life and in experiments, electricity and magnetism: relativity as a bridge

• Discuss the difference between classical andrelativistic momentum • Describe conservation of momentum inrelativity • Understanding the concept of relativistic massand conservation of mass	**Unit V: Relativistic momentum and mass (4)** Classical and relativistic momentum: from Newton'slaw, conservation of momentum in relativity, Propermass, second relativistic law, conservation of mass inrelativity
□Understanding the rest energy of relativisticparticle □Formulation of mass-energy formula □Describe the experimental tests of mass-energy relationship. □Understanding kinetic energy at low speeds	**Unit VI: Mass and Energy (5)** Rest energy, kinetic energy, total energy, conservation ofenergy, kinetic energy at low speeds, mass equivalent energy, mass-energy formula, direct test of mass-energy relationship
□Describe energy momentum relation and itsimplications □Description about mass-less particle regardingrelativity	**Unit VII: Energy and momentum (3)** Total energy, momentum, energy-momentum relation,massless particles
□Understanding the concept of gravity in the special theory of relativity □Description about principle of equivalence □Understanding the relation between gravityand electromagnetic wave □Evidences of verification of general relativity	**Unit VIII: General theory of relativity (6)** Einstein theory of gravitation, principal of equivalence,gravity and light, other findings of general relativity

Text and Reference Books

1. *Beiser A., Mahajan S. and Choudhury S. R*. - **Concepts of Modern Physics**, Tata McGrawHill Education, New Delhi (2011)
2. *Murugeshan R. and Sivaprasad K*. - **Modern Physics**, S. Chand and Company, New Delhi(2012)
3. *Rindler Wolfgang* - **Introduction to Special Relativity**, 2nd ed., Oxford University Press(1991)
4. *Das Anadijiban* - **The Special Theory of Relativity: A Mathematical Approach**, Springer-Verlag (1996)
5. *Schutz Bernard F*. - **A First Course in General Relativity**, Cambridge University Press(1985)

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Chemistry VI F.M.: 100
Course No.: CHM361 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Third, Semester: Sixth Teaching Hours: 45

1. Course Description:

The course intends to enable the students to be acquainted with the basic concepts of chemistry in all three branches of physical, organic and inorganic chemistry. Students will be familiarized with fundamentals of the surface phenomena, polymer chemistry, carbonyl condensation reactions, amines, aromatic nitro-compounds, hydrogen and detailed studies of preparation, properties, bonding, structure and applications of some selected compounds of boron and silicon, interhalogens compounds and pseudohalogens.

2. Course Objectives:

The general objectives of the course are as follows:

- To acquaint the students with fundamentals knowledge of adsorption phenomena, its applications and polymer chemistry.
- To familiarize the students with carbonyl condensation reactions, amines, aromatic nitro-compounds.
- To acquaint the students with basic concept of hydrogen, its isotopes and hydrides.
- To enable the students to understand the detail of some important compounds of boron and silicon, interhalogens and pseudohalogens.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Explain the adsorption, absorption & sorption phenomena with examples. • Enable the students to differentiate between physical & chemical adsorption. • Describe different types of adsorption isotherms. • State the postulates, derivation, interpretation of Freundlich & Langmuir isotherms and their limitations. • Describe the postulates, equation & limitations of BET adsorption isotherm. • Enable the students to determine the surface area of solids using BET equation. • Outline main applications of adsorption. • Explain the structures of soap, detergents and their cleansing actions. • Enable the students to solve numerical problems related with adsorption.	**Physical Chemistry** **Unit I: Surface Phenomena (10 hrs)** Adsorption, absorption and sorption, physical and chemical adsorption, factors affecting the adsorption, types of adsorption isotherms, Adsorption isotherms: Freundlich and Langmuiradsorption isotherms (postulates, derivation, interpretation andlimitation), Brunauer-Emett-Teller (BET) adsorption isotherm(postulates, equation and limitation), determination of surface areaof solid adsorbents by BET method, applications of adsorption, soapand detergents, cleansing actions of soap and detergents, related numericals.

- Briefly explain the different types of polymers.
- Describe the mechanism of addition, condensation, free radical and ionic polymerizations.
- Discuss some important properties of polymers and their applications.
- Define the degree of polymerization.
- Enable the students to solve numerical problems related with polymerization.
- Explain the mechanism of condensation reactions of carbonyl compounds.
- Describe Aldol condensation mechanism in different reaction condition.
- Explain the applications of Aldol reaction in different sector of organic synthesis.
- Discuss the mechanism and applications of Claisen condensation and Dieckmann reaction.
- Describe the reactions of conjugated carbonyl compounds.
- Discuss the mechanism of enamine forming reactions and their applications in organic synthesis.
- Explain the reaction, mechanism and applications of Michael reaction in organic synthesis.
- Describe the reaction and mechanism of Stork reaction with applications.
- Discuss the reactions and mechanism of Robinson annulation reaction.

- Explain the nomenclature of different organic amines.
- Describe the physical & chemical properties of aliphatic & aromatic amines.
- Discuss the application of Henderson-Hasselbalch equation in chemistry of amine.
- Discuss the reaction and mechanism involving in the synthesis of amines.
- Describe the Hofmann and Curtius reactions in the preparation of amine.
- Discuss the reactions of amines with mechanism.
- Describe the electrophilic substitution reactions and mechanism of amines with electrophile in aromatic amines.
- Discuss the reaction, mechanism and applications of Sandmeyer and diazonium coupling reaction.

Unit II: Polymers and Polymerization (5 hrs)

Introduction, types of polymers (homo- & copolymers, isotactic, atactic, syndiotactic, copolymers, natural organic and inorganic polymers), types of polymerization mechanisms (addition,condensation, free radical & ionic polymerizations), properties of polymers, applications of polymers, degree of polymerization,

related numericals.

Organic Chemistry

Unit III: Carbonyl Condensation Reactions (7 hrs)

Carbonyl condensation: aldol condensation, carbonyl condensation versus alpha substitution, dehydration of aldol product: synthesis of enones, using aldol reactions in synthesis, mixed aldol reactions, intramolecular aldol reactions, Claisen condensation, mixed Clasisen condensation, intramolecular Claisen condensations: Dieckmann cyclization, conjugate carbonyl addition: The Michael reaction, carbonyl condensation with enamines: Stork reaction, Robinson annulation reaction, some biological carbonyl condensation reaction.

Unit IV: Amines (5 hrs)

Naming amines, properties of amines, basicity of amines, basicity of substituted aryl amines, biological amines and the Henderson-Hasselbalch equation, synthesis of amines, reduction of nitriles, amide, and nitro compounds, SN2 reactions of alkyl halides, reductive amination of aldehydes and ketones, Hofmann and Curtius rearrangements, reactions of amines, alkylation and acylation, Hofmann elimination, reactions of aryl amines, electrophilic aromatic substitution reaction, Diazonium salts: Sandmeyer reaction, diazonium coupling reaction.

Unit IV: Aromatic Nitro Compounds (3 hrs) Preparation of aromatic nitro compounds by direct nitration, preparation, properties and reactions of nitrobenzene, orientation and reactivity of electrophilic substitution reactions of nitrobenzene, trinitrotoluene.

• Explain the nomenclature and preparation of aromatic nitro compounds. • Describe the physical and chemical properties of nitrobenzene. • Explain the mechanism of nitration of aromatic nitro compounds. • Discuss the orientation and reactivity of nitrobenzene towards electrophilic substitution reaction. Discuss the industrial preparation and utility of trinitrotoluene (TNT).	
• Explain the isotopes of hydrogen. • Explain the isotope effect in hydrogen and its application. • Describe the types of binary compounds of hydrogen.	**Inorganic Chemistry** **Unit V: Hydrogen (3 hrs)** Composition of naturally occurring hydrogen, isotopes of hydrogen, isotope effect, hydrides: ionic, covalent, interstitial and intermediate hydrides.
• Describe the structure, bonding, applications and mode of preparation of some important compounds of boron and silicon. • Describe the types of interhalogen compounds. • Explain the nature of Pseudohalogens. • Explain the modern concept of electronegativity, electron affinity and ionization energies.	**Unit VI: Structure, Bonding, Preparation, Properties and Applications of the Following (6 hrs)** Borohydrides, boron trifluoride, borazines, silicates, silicones, interhalogen compounds and pseudohalogens. **Unit VII: Electronegativity, Electron Affinity and Ionization Energies (6 hrs)** Recent advances in electronegativity theory, choice of electronegativity system, group electronegativity, electronegativity equalization, ionization energy, electron affinity curves, anomalous electron affinity and ionization energies.

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 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
- 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 Texts for CHM361:

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. John McMurry, **Organic Chemistry**, 7th Edition, Brookes/Cole, 2008.
4. J. D. Lee, **Concise Inorganic Chemistry**, 5th Edition, John Wiley and sons. Inc., 2007.
5. James, E. Huheey, Ellen A. Keiter & Richard L. Keiter, **Inorganic Chemistry: Principles of Structure andReactivity,** Addison Wesley Publishing House.

4. References for CHM361:

1. S. Negi & S. C. Anand, **A Textbook of Physical Chemistry**, New Age International Pvt. Ltd., New Delhi, 1999.
2. A. Bahl, B. S. Bahl & G. D. Tuli, **Essential of Physical Chemistry**, Revised Multicolour Edition, S. Chand & Co.Ltd., New Delhi, 2012.
3. M. R. Senapati, **Advanced Engineering Chemistry**, 2nd Edition, Infinity Science Press LLC, Hingham, Massachusetts, 2007.
4. F. Daniels & R. F. Alberty, **Physical Chemistry**, John Wiley & Sons, Latest Edition.
5. R. T. Morrison & R. N. Boyd, **Organic Chemistry**, Prentice- Hall of India Pvt. Ltd., 2008.
6. J. S. H. Pine, **Organic Chemistry**, McGraw Hill International Edition Series, New York, USA, 1987.
7. F. A. Cotton, G. Wilkinson & C. Gaus**, Basic Inorganic Chemistry**, John Wiley & Sons (Asia) Pvt. Ltd., 2007.
8. D. F. Shriver & P. W. Atkins, **Inorganic Chemistry**, W. H. Freeman and Co., London, 2014.
9. B. R. Puri, L. R. Sharma & K. C. Kalia, **Principles of Inorganic Chemistry**, Shoban Lal Nagin Chand and Co.,Delhi, India, 1996.
10. F.A. Corey and R.M. Giuliane, **Organic chemistry,** 8th Edition, Tata McGraw Hill Education Pvt.Ltd. 2012.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Chemistry VI PR F.M.: 100
Course No.: CHM361 P.M.: 45%
Nature of Course: Practical Credit: 1
Level: B. Sc. Number of hours per week: 3
Year: Third, Semester: Sixth Teaching Hours: 45
(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 heat of neutralization, conductance, adsorptionisotherms, determination of polymers' molecular weight and soap/detergents' cleansing action.
- To enable the students to perform experiments on different chromatographic techniques.
- To enable the students to develop skill on the preparation and characterization of inorganic complexes and water pollution parameter.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Enable the students to estimate the heat of neutralization of strong acid & strong base. • Enable the students to verify Onsager's equation & to estimate equivalent conductance at infinite dilution. • Enable the students to verify Freundlich & Langmuir adsorption isotherms. • Enable the students to determine the molecular weight of high polymeric materials. • Enable the students to compare the cleansing action of different soap & detergent available in local market.	**Unit I: Physical Chemistry Practical (15 hrs)** 1. To determine the heat of neutralization of HCl and NaOH. 2. To verify Onsager's equation and to determine the equivalent conductance of a strong electrolyte at infinite dilution. 3. To study the adsorption of acetic acid from aqueous solution by activated charcoal and to verify the Freundlich/Langmuir's adsorption isotherm. 4. To determine the molecular weight of a high polymer by viscosity measurement. 5. To determine the surface tension of soap and detergent solutions by drop number method and compare their cleansing action.
• Enable students to perform experiment of separation, identification and purification of organic compounds and natural products using different chromatographic techniques.	**Unit II: Organic Chemistry Practical (15 hrs)** 1. Separation of organic compounds (amino acids) by paper chromatography. 2. Separation of mixture of organic compounds by TLC. 3. Separation and identification of organic compounds by co-TLC. 4. Separation and purification of mixture of organic compounds by column chromatography. 5. Separation of natural products by chromatographic techniques.

• Enable students to perform experiment to determine dissolved oxygen (DO) in water sample. • Enable students to prepare & characterize some important inorganic complexes.	**Unit III: Inorganic Chemistry Practical (15 hrs)** 1. Determination of dissolved oxygen (DO) in water sample by Winkler'siodometric method. 2. Preparation of cuprous thiourea complex. 3. Preparation of ferrous ammonium sulphate (Mohr's salt). 4. Preparation of potassium trioxalato chromate (III) trihydrate. 5. Preparation of potassium trioxalato ferrate (III) trihydrate and estimation of percentage of oxalate present in the complex.

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 signedby the concerned teacher. They should write their reports in a chemistry practical copy and to keep them neat and properly.

4. Prescribed Texts for CHM 363:

1. David P. Shoemaker, Carl W. Garland & Joseph W. Nibler, **Experiments in Physical Chemistry,** 5th edition,McGraw-Hill Book Company, 1989. (Latest Edition).
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. J. N. Gurtu & R. Kapoor, **Advanced Experimental Chemistry** (Vol I – III), S. Chand and Co., New Delhi, India,1989. (Latest edition).
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. A. L, Vogel, **Qualitative Inorganic Analysis**, Prentice Hall, Latest Edition.
7. L. Shriner, R. C. Fusion & D. Y. Curtin, **The Systematic Identification of Organic Compounds, A LaboratoryManual**, John Wlley and Sons Inc, New York, USA , 1980. (Latest Edition).
8. N. S. Gnanapragasam & G. Ramamurthy, **Organic Chemistry– Lab Manual,** S. Viswanathan Co., Pvt., India,1998.
9. **Vogel's Text Book of Inorganic Qualitative Analyses**, 4th Edition, ELBS, London, 1974. (Latest Edition).
10. P. N. Yadav, M. R. Pokhrel & S. Shrestha, **Advanced Practical Inorganic Chemistry,** Kshitiz Publication, Kahmandu, 2017.
11. N. M. Khadka, S. D. Gautam & P. N. Yadav, **A Core Experimental Chemistry for B.Sc.**, Heritage Publication,Kathmandu, 2016.
12. M. K. Sthapit & R. R. Pradhananga, **Experimental Physical Chemistry**, Taleju Prakasan, Kathmandu, Nepal,1998.
13. K. N. Ghimire, M. R. Pokhrel K. P. Bohara**, University Experimental Inorganic Chemistry**, Quest Publication,Kirtipur, Kathmandu, Nepal, 2008.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Chemistry VII F.M.: 100
Course No.: CHM362 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Third, Semester: Sixth Teaching Hours: 45

1. Course Description:

The course intends to enable the students to be acquainted with the fundamental concepts of chemistry in all three branches of physical, organic and inorganic chemistry. Students will be familiarized with different molecular spectroscopic (rotational, vibrational, Raman, electronic and nuclear magnetic resonance) techniques, heterocyclic compounds and reaction intermediates, fertilizers and environmental pollution.

2. Course Objectives:

The general objectives of the course are as follows:

- To enable the students with basic theoretical and practical knowledge of rotational, vibrational, Raman, electronic and NMR spectroscopic techniques.
- To familiarize the students with basic knowledge of heterocyclic compounds and reaction intermediates.
- To acquaint the students with basic concept of technical method of preparation, importance and environmental impact of chemical and bio-fertilizers.
- To enable the students to understand the basic concept of air, water and soil pollution.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Discuss the basic knowledge of electro- magnetic radiation, origin and types of molecular spectra. • Enable the students with basic knowledge of rotational (microwave) spectroscopic technique, • Describe the concept of dipole moment and rotation spectra. • Explain rotational energy levels of a molecule. • State and explain the selection rules of rotational spectra. • Describe applications of rotational spectroscopy. • Enable the students with basic concept of IR spectroscopic technique. • Explain the energy levels of simple harmonic oscillator. • State and explain the selection rules of vibrational spectra. • Describe the effect of anharmonic motion and vibrational modes. • Explain the origin of pure vibrational and vibration-rotation spectra (P, Q, R braches). • Enable the students to apply IR spectra in various aspects.	**Physical Chemistry** **Unit I: Rotational & Vibrational Spectroscopy (8 hrs)** Electromagnetic radiation and spectra, atomic and molecular spectra, origin of molecular spectra, types of molecular spectra. *Rotational spectrum:* microwave spectrum, concept of dipole moment and rotation spectra, rotational energy levels of molecules, selection rule of rotational spectra, applications of rotational spectroscopy. *Vibrational spectrum:* infrared spectrum, energy levels of simple harmonic oscillator, selection rules of vibrational spectra, pure vibrational spectrum, effect of anharmonic motion, vibrational modes of molecules, vibration-rotation spectra, applications of infrared spectroscopy (structure elucidation & identification of a compound, determination of purity & force constant, reaction kinetic study and others), related numericals

• Describe the concept of polarizibility. • Explain pure rotational and vibrational Raman spectra of diatomic molecules.	**Unit II: Raman & Electronic Spectroscopy (4 hrs)** *Raman spectrum:* concept of polarizibility, pure rotational and
• State and explain selection rules of Raman spectra. • Explain Franck-Condon principle & describe electronic transitions. • State and explain the selection rules of electronic spectra. • Discuss the applications of electronic spectroscopy.	vibrational Raman spectra of diatomic molecules, selection rules. *Electronic spectrum:* introduction, Franck-Condon principle, types of electronic transitions, selection rules, applications of electronic spectroscopy.
• Explain the basic principles of NMR. • Discuss about the electrons and nuclei in magnetic field. • Brief introduction of different NMR techniques of ^{1}H-NMR, ^{13}C-NMR, Fourier transform-NMR and electron magnetic resonance. • Describe the terms of chemical shift and spin-spin coupling constant to elucidate the structure of compounds.	**Unit III: NMR Spectroscopy (3 hrs)** Principles of nuclear magnetic resonance (NMR) spectroscopy, electrons and nuclei in magnetic field, NMR techniques, chemical shift, spin-spin coupling, applications of NMR spectra.
• Describe about the structure sources and utility of heterocyclic compounds. • Describe the sources of pyrrole, furan and thiphene. • Explain the chemical and physical properties of pyrrole, furan and thiphene. • Discuss the mechanism of electrophilic substitution reactions of pyrrole, furan and thiophene. • Discuss the structure and applications of tetrahydrofuran and differences between furan and THF. • Discuss the structure, sources and applications of pyridine in organic synthesis. • Explain the electrophilic and nucleophilic substitution reactions of pyridine. • Describe the aromatic characters of heterocyclic compounds. • Introduce the structure and applications of polycyclic heterocyclic compounds.	**<u>Organic Chemistry</u>** **Unit IV: Heterocyclic Compounds (7 hrs)** Introduction, sources of pyrrole, furan and thiophene, structure, preparation and properties of pyrrole, furan and thiophene, electrophilic substitutions in pyrrole, furan and thiophene (reactivity and orientation), tetrahydrofuran, structure of pyridine, source of pyridine compounds, reactions of pyridine, electrophilic substitution in pyridine, nucleophilic substitution in pyridine, aromaticity of heterocyclic compounds, polycyclic heterocycles.

• Explain the importance of study of different reaction intermediates in chemistry. • Discuss the stability, structure, generation, reactivity, fate and chemistry of carbocation, carbanion, carbene, nitrene free radical, benzyne, nonclassicalcarbonium ion and areniumion. • Discuss the relative stability of different types of carbocations, carbaanions, free radicals. • Describe the utility of these reaction intermediates in the determination of mechanism of the reaction.	**Unit V: Reaction Intermediates (8 hrs)** Introduction, Stability, structure, generation, reactivity, fate and chemistry of carbocation, carbanion, carbene, nitrene free radical, benzyne, nonclassical carbonium ion and arenium ion.
• Explain the importance of chemicalfertilizers. • Describe the role of major andmicronutrient for plant. • Describe technical method of preparationof some major fertilizers.	**Inorganic Chemistry** **Unit V1: Fertilizers (6 hrs)** Chemical and bio-fertilizers, importance of chemical fertilizers, role of N, P and K as plant fertilizer, minor ingredients, industrial synthesis of
• Explain the nitrogen fixation and models fordinitrogen complexes. • Describe the major phosphate fertilizers. • Explain the environmental impact of theuse of chemical fertilizers.	ammonia, manufacture of urea, nitrogen fixation, dinitrogen complexes, super phosphates and triple phosphates, environmental impact of synthetic fertilizers.
• Introduce the concept of environmental pollution. • Describe the sources of air pollution and types of air pollution. • Describe the type of gas pollutant andparticulates. • Explain smog, acid rain, ozone depletion. • Describe the types and sources of water pollution. • Explain some pollution parameters. • Describe methods of waste water treatment. • Describe the sources of soil pollution and its control measure. • Explain the biodegradation and environmental impact of pesticides. □	**Unit VII: Environmental Pollution (9 hrs)** An introduction to the pollution in the air, water and soil. *Air pollution:* Sinks of atmospheric gases, major sources of atmospheric pollution, natural and anthropogenic sources. Classification of air pollutants based on a) origin b) chemical composition c) state of pollutants. *Gaseous pollutants:* NO_X, oxides of sulphur, oxides of carbon, hydrocarbons. *Particulates:* inorganic particulate and organic particulate. Smogs, acid rain, ozone depletion. *Water pollution:* Classification of water pollution, types and sources of water pollution, control of water pollution, pollution parameters: DO, BOD, COD, total alkalinity, Eutrophication, waste water treatment. *Soil pollution:* sources of soil pollution, control of soil pollution, wastes

	and pollutants in soil, pesticide and its biodegradation.

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 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
- 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 Texts for CHM362:

1. 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.
2. S. H. Maron & C. Prutton, **Principles of Physical Chemistry**, Oxford and IBH Publication and Co., 1992.
3. John McMurry, **Organic Chemistry**, 7th Edition, Brookes/Cole, 2008.
4. J. D. Lee, **Concise Inorganic Chemistry**, 5th Edition, John Wiley and sons. Inc., 2007.
5. G. T. Miller Jr, **Living in the Environment: An Introduction to Environmental Science***,* Wardsworth Publication, California, USA, 1994.
6. A. K. De, **Environmental Chemistry**, New Age International Publishers, New Delhi, India, 2008.
7. J. March, **Advanced Organic Chemistry,** 4th Edition, John Wiley and Sons, 2001.

6. References for CHM362:

1. F. Daniels & R. F. Alberty, **Physical Chemistry**, John Wiley & Sons, Latest Edition.
2. Gilbert. W. Castellan, **Physical Chemistry**, Narosa Publishing House, 1985.
3. S. Negi & S. C. Anand, **A Textbook of Physical Chemistry**, New Age International Pvt. Ltd., New Delhi, 1999.
4. A. Bahl, B. S. Bahl & G. D. Tuli, **Essential of Physical Chemistry***,* Revised Multicolour Edition, S. Chand & Co.Ltd., New Delhi, 2012.
5. R. T. Morrison & R. N. Boyd, **Organic Chemistry**, Prentice- Hall of India Pvt. Ltd., 2008.
6. J. S. H. Pine, **Organic Chemistry**, McGraw Hill International Edition Series, New York, USA, 1987.
7. F.A. Corey and R.M. Giuliane, **Organic chemistry,** 8th Edition, Tata McGraw Hill Education Pvt.Ltd. 2012.
8. F.A. Cotton, G. Wilkinson & C. Gaus**, Basic Inorganic Chemistry**, John Wiley & Sons (Asia) Pvt. Ltd., 2007.Edition, Tata McGraw Hill
9. D. F. Shriver & P. W. Atkins, **Inorganic Chemistry**, W. H. Freeman and Co., London, 2014.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Differential Equations F.M.: 100
Course No.: MTH361 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Third, Semester: Sixth Teaching Hours: 45

(1). Course description

The course of Mathematics is designed to gain the knowledge about basic concepts of differential equations like first order linear and non-linear differential equations, second order differential equations and higher order linear equations as well as partial differential equations. The course emphasizes both theoretical and applicable aspects of ordinary differential equations and partial differential equations.

(2). Course objectives

The general objectives of the course are as follows:

- To enable the students to gain the basic concepts of solution of differential equations.
- To enable the students to know about linear and non-linear differential equations of first order.
- To know about second order linear equations.
- To enable the students to know about partial differential equations.

(3). Specific objectives and course contents

Specific objectives	Contents in Detail
• Define differential equation with examples. • Classify the differential equations. • Solve the differential equations by different methods. • Describe about some mathematical modules and directional fields.	**Unit 1: Introduction (4 hours)** Definition and classification of differential equations Solution of differential equations Some mathematical modules and directional fields
• Discuss about separable equations and solve them. • Describe about integrating factors. • Discuss about moduling with first order differential equations. • Discuss about differences between linear and non-linear differential equations. • Solve autonomous equations and discuss about population dynamics. • Discuss about exact equations and integrating factors. • Discuss about numerical approximations. • Solve the differential equations by Euler's method. • State and prove existence and uniqueness theorem. • Solve different types of first order differential equations.	**Unit 2: First Order Linear and Non Linear Differential Equations (9 hours)** Separable equations Integrating factors Moduling with first order differential equations Differences between the linear and non-linear equations Autonomous equations and population dynamics Exact equations and integrating factors Numerical approximation Euler's method Existence and uniqueness theorem First order differential equations
• Discuss about homogeneous equation with constant coefficients. • Solve linear homogeneous differential equations. • Discuss about the wronskian, complex roots of characteristic equations. • Discuss about repeated roots and reduction of order. • Discuss about non-homogeneous equations. • Solve the equations of method of undetermined coefficients. • Discuss about variations of parameters.	**Unit 3: Second Order Linear Equations (12 hours)** Homogeneous equations with constant coefficients Solutions of linear homogeneous equations The wronskian, complex roots of characteristic equation Repeated roots and reduction of order Non-homogeneous equations Method of undetermined coefficients Variations of parameters

• Discuss about partial differential equations (PDE) of first order. • Discuss about surface and curves in three dimensions. • Solve the equations of the type $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$. • Discuss about orthogonal trajectories of system of curves on a surface. • Solve the differential equations by Charpit's method.	**Unit 4: Ordinary Differential Equations in More than Two Variables (8 hours)** Partial differential equations of the first order Surface and curves in three dimensions Method of solution of the equation $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ Orthogonal trajectories of system of curves on a surface Charpit's differential forms and equations
• Define partial differential equations of first order. • Discuss about origin of PDEs. • Discuss about Cauchy problems of first order PDEs. • Solve the linear PDEs of first order. • Discuss about integral surface passing through a given curved surface.	**Unit 5: Partial Differential Equations (12 hours)** Partial differential equations of first order Origin of first order PDEs Cauchy problems for first order equations Linear equations of first order
• Solve PDEs by Charpit's method. • Solve the special types of first order PDEs.	Integral surface passing through a given curved surface Charpit's method Special types of first order equations

(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 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. Bayce, W. and DiPrima, R., Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India
2. Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill International Edition
3. James C. Robinson, An Introduction to Ordinary Differential Equations, Cambridge University Press.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Mechanics F.M.: 100
Course No.: MTH362 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Third, Semester: Sixth Teaching Hours: 45

(2). Course description

The course of Mathematics is designed to enable the students about to gain the basic knowledge about coplanar forces, virtual work, catenary, centre of gravity, kinematics in two dimensions, rectilinear motion, moments and products of inertia. After the study of these topics, the students will familiarize and able to understand the subject matter and their applications in other fields.

(3). Course objectives

The general objectives of this course are as follows:

- To enable the students to gain basic knowledge about coplanar forces and virtual work.
- To enable the students to know about catenary and centre of gravity.
- To enable the students to know about kinematics in two dimensions, rectilinear motion, moments and products ofinertia.

(4). Specific objectives and course contents

Specific objectives	Contents in Detail
• Discuss about resultant of coplanar forces. • Derive the equation to the resultant. • Discuss about equivalent forces and couples. • Find the general condition of equilibrium. • Find the work done by the resultant. • Discuss about virtual displacement and virtual work. • Discuss about principle of virtual work for a systemof coplanar forces acting on a particle.	**Unit 1: Coplanar Forces and Virtual Work (10 hours)** Resultant of coplanar forces Equation to the resultant Equivalent forces and couples General condition of equilibrium Work done by resultant Virtual displacement Virtual work Principle of virtual work for a system of coplanar forcesacting on a particle
• Define catenary. • Find the equation of common catenary in intrinsicand Cartesian form. • State the properties of common catenary. • Discuss about approximation to the common catenary. • Discuss about sag of a tightly stretched wire.	**Unit 2: Catenary (8 hours)** Definition Equation of common catenary in intrinsic and Cartesian form Properties of common catenary Approximation to the common catenary Sag of a tightly stretched wire
• Define centre of mass and centre of gravity. • Find centre of gravity by integration. • Find centre of gravity by an arc, CG of a plane area. • Find centre of gravity of a solid of revolution. • Find centre of gravity of a surface of revolution. • Discuss about centre of gravity of the sum or differences of two bodies.	**Unit 3: Centre of Gravity (10 hours)** Centre of mass Centre of gravity Centre of gravity by integration Centre of gravity by an arc Centre of gravity of a plane area Centre of gravity of a solid revolution Centre of gravity of a surface of revolution Centre of gravity of the sum or differences of two bodies
• Define velocity and acceleration of particle in plane. • Find radial and transverse components of velocityand acceleration. • Find angular velocity and acceleration. • Find tangential and normal components of	**Unit 4: Kinematics in Two Dimensions (6 hours)** Motion in plane – velocity and acceleration Radial and transverse components of velocity and acceleration Angular velocity and acceleration Tangential and normal components of acceleration

acceleration.	
• Define simple harmonic motion. • Discuss about motion under inverse square law. • Define moments and products of inertia.	**Unit 5: Rectilinear Motion, Moments and Products of Inertia (11 hours)** Simple harmonic motion (SHM) Motion under inverse square law
• Discuss about some simple cases on MI and PI ofinertia.	Motion under laws of forces Moments and products of inertia Motion of inertia in some simple cases

(5). 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 assignmentwill be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests willbe 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.

(6). Prescribed Books and References

1. C. M. Joshi, J. C. Joshi and R. D. Joshi, A Textbook of Mechanics, Buddha Academic Publishers and Distributors,Kathmandu
2. M. Ray, Textbook of Dynamics, S. Chand and Company Ltd., India
3. R. S. Verma, Textbook of Statics, Pothishala Pvt. Ltd., Allahabad, India