Master of Technology in Environmental Engineering

Prospectus – 2017

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Outline of the Program

Aim of the Program

The sustainable development of any country needs to recognize the intimate and intricate relationship between the human activities and the environment. With the rise in haphazard development processes, we risk irrecoverable damage to our environment through urgent and pervasive problems like pollution and impact of the built environment on our ecosystem. Hence, this program aims to equip the students with a sound knowledge-base of technical and engineering principles to assess and eliminate the environmental pollution in the environmental media, viz., air, water and soil. This task involves the techniques to increase the quality of life and sustainably protect the environment through integration of diverse domains of science and engineering, with focus on mass and energy principles, and the understanding of physical, chemical and biological processes in the natural and engineered environments.

The graduates have diverse job opportunities, such as government jobs, environmental impact assessments, pollution control in process industries, environmental consultancies, non-governmental organizations associated with environmental protection, wastewater treatment plants, water supply facilities, sewage treatment plants, air pollution control, solid waste management, sustainable energy development, urban planning, and so on.

The graduates of this program will be able to:

- Understand the processes governing the transport and transformation of the environmental pollutants from the source of emission to the receptor of the pollution.

- Understand the present and the future behavior of the environmental systems under the influence of anthropogenic activities and the ensuing engineering interventions.

- Propose the most appropriate control technologies to minimize the waste and pollution after quantitatively assessing the environmental impacts and the broader implications of anthropogenic and engineering activities such as infrastructure projects and engineering structures.

- Specialize in water treatment, air quality improvement and waste management.

Program Duration: Two years
Course Type: Engineering
Total Credit Hours: 60

Admission Requirements

1. The general admission requirements of Kathmandu University for the master’s degree must be fulfilled.

2. The prior educational degree should be a four-year undergraduate degree in Engineering with minimum 50% aggregate or CGPA of 2.0 from any recognized university.

3. There will be entrance exam and screening interview.
# Course Structure

<table>
<thead>
<tr>
<th>Code</th>
<th>Name of the course</th>
<th>Cr.</th>
<th>Type of Course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year I Semester I</strong></td>
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<tr>
<td>ENVE 501</td>
<td>Environmental Chemistry and Microbiology</td>
<td>3</td>
<td>Core</td>
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<tr>
<td>ENVE 502</td>
<td>Computational Tools and Techniques for Environmental Engineers</td>
<td>3</td>
<td>Core</td>
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<tr>
<td>ENVE 503</td>
<td>Environmental Dynamics</td>
<td>3</td>
<td>Core</td>
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<tr>
<td>ENVE 504</td>
<td>Water Quality Engineering</td>
<td>3</td>
<td>Core</td>
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<tr>
<td>ENVE 505</td>
<td>Air Pollution Engineering</td>
<td>3</td>
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<td></td>
<td><strong>Total Credits</strong></td>
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<tr>
<td><strong>Year I Semester II</strong></td>
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<tr>
<td>ENVE 506</td>
<td>Solid Waste Engineering</td>
<td>3</td>
<td>Core</td>
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<tr>
<td>ENVE 507</td>
<td>Green Engineering</td>
<td>3</td>
<td>Core</td>
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<tr>
<td>ENVE 508</td>
<td>Environmental Process Modeling</td>
<td>3</td>
<td>Core</td>
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<tr>
<td>ENVE 53*</td>
<td>Elective I – Pool A</td>
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<tr>
<td>ENVE 53*</td>
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<td><strong>Year II Semester I</strong></td>
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<tr>
<td>ENVE 601</td>
<td>Environmental Economics, Policies and Legislations</td>
<td>3</td>
<td>Core</td>
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<td>ENVE 602</td>
<td>Environmental Impact and Risk Assessments</td>
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<td>ENVE 603</td>
<td>Colloquium in Environmental Engineering</td>
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<td>ENVE 604</td>
<td>Directed Study and Research Method for Thesis</td>
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<td>ENVE 53*</td>
<td>Elective III – Pool A</td>
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<td>Elective</td>
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<td>ENVE 63*</td>
<td>Elective IV – Pool B</td>
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<td>ESEE 548</td>
<td>Aerosol Science and Technology</td>
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<td>ESEE 532</td>
<td>Air Pollution Modeling</td>
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<td>ESEE 534</td>
<td>Atmospheric Chemistry</td>
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<tr>
<td>ESEE 533</td>
<td>Atmospheric Science</td>
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<td>ESEE 535</td>
<td>Climate Change: Mitigation Technologies and Policies</td>
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<td>ESEE 536</td>
<td>Climate Dynamics and Modeling</td>
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<td>ESEE 537</td>
<td>Design of Water Supply and Wastewater Systems</td>
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<td>ESEE 531</td>
<td>Disaster Risk and Vulnerability Assessment</td>
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<td>ESEE 547</td>
<td>Bioseparation and Bioremediation</td>
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<td>ESEE 539</td>
<td>Energy System Design Engineering</td>
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<td>ESEE 540</td>
<td>Engineering System Design for Sustainability</td>
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<td>ENVE 533</td>
<td>Hazardous Waste Technology and Management</td>
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<tr>
<td>ESEE 542</td>
<td>Indoor Air Pollution and Energy Analysis</td>
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<td>ESEE 543</td>
<td>Industrial Processes and Pollution Control</td>
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<td>ESEE 544</td>
<td>Vehicular Emission Control Engineering</td>
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<tr>
<td>ESEE 545</td>
<td>Waste Reduction and Recycling</td>
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<tr>
<td>ESEE 546</td>
<td>Water Resources Engineering</td>
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**Electives – Pool B (Environmental Planning and Management)**

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<tbody>
<tr>
<td>ESEE 631</td>
<td>Environmental Health and Safety in Industries</td>
<td>3</td>
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<tr>
<td>ESEE 632</td>
<td>Human Values and Personal Transformation</td>
<td>3</td>
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<tr>
<td>ESEE 633</td>
<td>Economic and Financial Analysis of Environmental Projects</td>
<td>3</td>
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<tr>
<td>ESEE 634</td>
<td>Principles of Cleaner Production</td>
<td>3</td>
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<tr>
<td>ESEE 635</td>
<td>Sustainability for the Environment</td>
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<tr>
<td>ESEE 636</td>
<td>Sustainable Industrial Systems</td>
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<tr>
<td>ESEE 637</td>
<td>Urban Energy and Environmental Planning</td>
<td>3</td>
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<tr>
<td>ESEE 638</td>
<td>Environmental Risk Analysis</td>
<td>3</td>
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</table>
Detailed Syllabus

ENVE 501 Environmental Chemistry and Microbiology

Objectives: Understand the fundamentals of chemical and biological processes in air, water and soil; Learn analytical and instrumental techniques involved; Understand the role of microorganisms in removal of pollutants.

Learning Outcomes: Ability to use chemical and microbial systems in waste treatment; Expertise in handling the instruments in analyzing the environmental parameters.

Content
Atmosphere: Composition of atmosphere, Evolution of atmosphere, Photochemical and chemical reaction in the atmosphere, Chemistry of green house effect and ozone layer depletion, Chemistry of ground-level air pollution.
Lithosphere: Water and air in soil, Organic and inorganic components in soil, Effects of ecological factors on toxicity of soil.
Toxic organic compounds: Pesticides, dioxins, Furans, PCBs, PAHs.
Environmental microbiology: Biodegradation in the aquatic environment, Degradation in heterogeneous environments, Microbial activity in trace heavy metal cycling, Eutrophication, Microbiological indicators of pollution.
Instrumental methods of analysis: Optical methods, Electrical methods, Chromatographic methods.
Laboratory: Hands-on practice in instrumental analysis and solution preparations.

References

ENVE 502 Computational Tools and Techniques for Environmental Engineers

Objectives: Use of GIS and remote sensing tools and techniques to quantify and analyze the spatial environmental information; Programming for environmental data processing and visualization

Learning Outcomes: Ability to generate, process and analyze the spatial environmental data; Ability to automate the processing and visualization of environmental data.

Content
Geocomputation and Geographic Information System: Database integration, Open-source GIS, automated mapping, data conversion, mobile computing, Open GIS web
service and software suite, GRASS GIS applications and case studies in water resource, watershed management, and environmental management, Geomatic surveying techniques.

Satellite remote sensing: Data and information system, Remote sensing data formats and format conversions, MODIS calibration and characterization, MODIS reprojection tool, MODIS data processing for regional use, TRMM data access tools, Other satellite data processing.

Advanced programming with Python: Data processing and visualization, Mapping of environmental data, Time series analysis and plotting, Solution of ODE and PDE, Statistical and numerical data analysis.

**Laboratory:** Hands-on practice in GRASS GIS, QGIS and Python.

**References**


**ENVE 503    Environmental Dynamics**

**Objectives:** Understand the fluid mechanical processes that govern the transport of pollutants; Learn the mechanism and rates of chemical transport in the environment through different environmental media.

**Learning Outcomes:** Ability to assess the transport of chemical pollutants in the environment; Ability to use tools and techniques to quantify the distribution of chemicals in the multimedia environment.

**Content**


Transport processes: Mass transfer, Diffusive transport, Diffusion equation, Diffusive transport in reactive systems, Convective transport, Chemical exchange between air and water, Chemical exchange between water and sediment, Chemical exchange between air and soil, Intraphase chemical transport and fate in water and air.
Laboratory: Study of environmental transport processes at lab.

References


ENVE 504 Water Quality Engineering

Objectives: Learn the physical and chemical treatment processes in environmental engineering; Understand the design principles of treatment devices; Learn the separation techniques for solids and soluble matters.

Learning Outcomes: Ability to design and operate the water and wastewater treatment plants.

Content
Reactors and reactions: Mass balances, Continuous flow reactors, Reaction kinetics.
Removal of particles from water: Particle treatment processes, Flocculation, Gravity separations, Granular media filtration, Filtration dynamics.
Membrane-based water and wastewater treatment: Membrane processes, Membrane system operation, Pressure-driven membrane systems, Electrodialysis.

Laboratory: Hands-on practice at water and wastewater treatment facilities.

References


ENVE 505 Air Pollution Engineering

Objectives: Understand the chemical kinetics and combustion process in air pollution; Learn the control technologies for mobile emissions, particulate emission and gaseous emissions; Learn design principles of air pollution control devices.
Learning Outcomes: Ability to design and operate air pollution control devices; Expertise in air quality testing and abatement.

Content

Introduction: Air pollutants, Chemical kinetics, Mass and heat transfer, Turbulent mixing, Air pollution control strategies.


Pollutant formation and control in combustion: Nitrogen oxides, Carbon monoxide, Hydrocarbons, Sulfur oxides.

Internal combustion engines: Spark ignition engines, Diesel engine.

Aerosols: Non-continuum effects, Motion of particles, Diffusion, Size distribution, General dynamic equation, Particle formation in combustion, Removal of particles from gas streams.


Laboratory: Hands-on practice in air pollution measurement and control devices.

References


Noel De Nevers. *Air pollution control engineering*. Waveland Press, 2010


Lawrence K Wang et al. *Advanced air and noise pollution control*. Springer, 2005

ENVE 506  Solid Waste Engineering

Objectives: Learn waste sampling, generation rate, characterization and composition of solid waste; Learn storage, collection, transportation of solid waste; Learn resource recovery and disposal.

Learning Outcomes: Ability to manage solid waste problems with storage and handling technologies; Expertise in waste to energy technology.

Content

Municipal solid waste characteristics and quantities: Generation, composition, properties.

Collection and mechanical processes: Refuse collection system, Design of collection systems, Conveying, compacting, shredding, pulping, granulating, roll crushing.

Separation processes: Screens, Float/sink separators, Magnets and electromechanical separators.

Biological processes: Anaerobic digestion, Composting

Special topics: Management of used oil, Medical and infectious waste, Construction and demolition debris, Electronic waste

**Laboratory**: Survey and design of waste-to-energy technologies and landfills.

**References**


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**ENVE 507 Green Engineering**

**Objectives**: Understand the concept of sustainable or green engineering based on global issues. Practices and methods to assess environmental quality, performance of engineered products or systems. Study laws, regulations, occupational health concerns and ethics in environmental engineering.

**Learning Outcomes**: To educate students the concept of sustainable and green engineering to maintain the environmental quality.

**Content**

Environmental issues and regulations: Risk assessment, Environmental laws and regulations, Roles of engineers in environmental protection, Process safety, Engineering ethics.

Improvement of environmental performance in engineering processes: Green chemistry, Unit operations and pollution prevention, flowsheet analysis for pollution prevention.

Green Engineering for products: Life-cycle assessment, industrial ecology, the economics of green engineering, Product stewardship.

Innovations in Green Chemistry and Green Engineering: Renewable materials, Green nanoscience.

**Laboratory**: Use of life-cycle assessment tools.

**References**


ENVE 508  Environmental Process Modeling

Objectives: Understand the development and deployment of environmental models in all the environmental media; Learn the process-based modeling techniques and practices in water quality and air quality; Understand the modeling of dynamical systems in the environment; Learn the system modeling approach to solve environmental problems.

Learning Outcomes: Ability to develop and use air quality and water quality models; Expertise in modeling the dynamical processes; Ability to integrate state-of-the-art modeling tools.

Content

Modeling methods: Types, Development, Application, Parameter estimation, Validation and sensitivity analysis.

Transport processes: Transport equation, Boundary and initial conditions, Transport with decay and degradation, Transport and sorption, kinetics, and equilibrium reactions.

Dynamical systems: River and lake quality models, flow modeling in porous media, Groundwater modeling, Aquifer baseflow and meshing, Potential and flow visualization.


2D and 3D Transport solutions: Gaussian puffs and plumes with constant line and instantaneous line sources.

System models: Simple reactor and bioreactor models, Population balance models, Artificial Neural Network models.

Laboratory: Modeling the environmental processes and flow systems using open-source programming.

References


ENVE 601  Environmental Economics, Policy and Legislations

Objectives: Learn the international and national laws and regulations related to environmental domains; Understand the development of environmental legislations and
policies.

**Learning Outcomes:** Awareness about the current laws, regulations and policies related to different environmental sectors.

**Content**


Solid waste facilities: Financing calculations, Contracting for solid waste services, Public or private ownership and operation, SWM Legislation.


Environmental policies and legislations of Nepal.

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**ENVE 602  Environmental Impact and Risk Assessments**

**Objectives:** Learn the methods of assessing the impacts of anthropogenic activities on the different environmental sectors; Understand the applications of risk assessment tools and environmental management systems.

**Learning Outcomes:** Ability to evaluate and predict the environmental impacts using quantitative tools; Expertise in environmental impact assessment and risk assessment.

**Content**

Processes for IEE, EIA, and TOR (components of EIA reports)

Methods for impact identification, Description of environmental setting.

Prediction and assessment of impacts on air, noise, water, soil, land use, terrestrial and aquatic ecology, Environmental indices and indicators.


**References**


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**ENVE 603  Colloquium in Environmental Engineering**

**Objectives:** Provide exposure to the views and opinions of the experts and professionals on the scope as well as challenges for the environmental engineering graduates.

**Learning Outcomes:** Strong interaction and linkage between the academic and professional expertise.

**Content**
Lectures on current research topic in environmental engineering and its related fields, which will be presented by faculty members and invited speakers.

ENVE 604  Directed Study and Research Method for Thesis

**Objectives:** Intensive preparation for the masters thesis work; Learn the methods and tools for the thesis research.

**Learning Outcomes:** Development of research method and review of the literature.

**Content**
Research and preparation for the thesis of the last semester. It will cover the development of the research theme, methodology and review of the literature.

ENVE 699  Thesis Research

**Introduction**
Research work and thesis submission will be carried out by the students with supervision by the assigned faculty members. It will cover the actual research work, thesis writing, oral defense of the thesis, and publication. The students may collaborate with relevant institutions with the permission of the department.

**Learning Outcomes**
Masters thesis on environmental engineering with strong academic merit.

**Guidelines for Master Thesis**

- Students need to develop the concept paper.
- On the base of the accepted concept paper the research proposal need to be developed.
- Supervisor will be assigned and all the modality of the proposal defense, thesis writing, thesis defense depends upon the location of the student's registration for research.
- Regular individual progress meetings with the supervisors will be held to monitor the progress on the research and thesis writing, and records of the progress will be kept.

**The Basis for Evaluating the Master Research**

- Problem statement and research topic and its rationale for research.
- In-depth literature review, including assessment of the usability of literature and previous research.
- Collection of relevant on-line and archived data.
- If appropriate, preparation and execution of fieldwork to collect primary data required for the research.
- Data processing and analysis and, if deemed necessary, adjustment of the research plan in consultation with the supervisors (based on sound arguments).
• Active participation in seminars and conferences related to the research theme.
• Mid-term presentation;
• Preparation of the final manuscript of the master thesis (hard-copy thesis and CD-ROM with thesis, appendices and full dataset including the original data and results);
• A critical review of the quality, use and usefulness of the data and results, as well as the learning process;
• Oral presentation and defense of the master thesis before the Thesis Assessment Board.
Evaluation Scheme

Courses

The academic performance of the students will be judged through:

- Continuous assessment, and
- Final assessment

The continuous assessment of the student will be made by the concerned faculty member in any or a combination of the following:

- Written tests
- Assignments and reports
- Seminars
- Term papers
- Any other deemed suitable by the concerned faculty member.

The final assessment will normally be conducted according to the examination schedule notified by the concerned office for a distributed course and at the end of course for an intensive type course. The mode of evaluation in a given course is decided by the concerned faculty member who may assign varying weights to one or more of the evaluation modes. The faculty member shall normally announce such weights in the beginning of the course.

Masters Thesis

A thesis in topic related with the student’s discipline is a necessary requirement for the successful completion of M.Tech. in Environmental Engineering. The candidate must have achieved result of significance in the thesis work and must indicate an ability to express in satisfactory style, both in written and oral.

Normally the thesis shall be submitted at the end of the final semester. However, upon the recommendation of the supervisor, and subject to the approval of the School, only one term extension of six months can be granted to a student if he/she requires so. The student will receive a satisfactory or unsatisfactory grade and must have a satisfactory grade to qualify.

Grading Modes

In each course, student will be evaluated on a 4 point scale as follows:

<table>
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<tr>
<th>Grade</th>
<th>A</th>
<th>A–</th>
<th>B+</th>
<th>B</th>
<th>B–</th>
<th>C+</th>
<th>C</th>
<th>F</th>
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<td>3</td>
<td>2.7</td>
<td>2.3</td>
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</table>

The grades indicate the quality of students’ performance as follows:
A = Outstanding
A– = Excellent
B+ = Very good
B = Good
B– = Fair
C+ = Poor
C = Very Poor
F = Failure

Apart from the letter grades mentioned above, the following letter grade can also be awarded:
W = Withdrawn
NC = Non Credit Course
INC = Incomplete
S = Satisfactory
U = Unsatisfactory
AU = Audit

W Indicates that a student has officially withdrawn from a course without grade or penalty. During the regular semester, a student seeking to withdraw from a course must do so before the final examination with the permission of the concerned faculty member. ‘W’ may not be processed after the final examination.

NC Indicates that a student has officially attended a course till the end and completed it successfully but for which no credit will be given. A student can take a non

INC Indicates that a student has not completed all the assignments required in the particular course. ‘INC’ becomes ‘F’ if the student does not complete the required work before the deadline agreed upon with the concerned faculty. A maximum of 6 months will be allowed for ‘INC’ removal.

S Indicates completion of dissertation at satisfactory level.

U Indicates dissertation was not completed at a satisfactory level.

AU Indicates completion of credit course on top of the required credited courses.

**Graduation Requirement**

To graduate a student must achieve the following:

1. Completion of the minimum number of required course credit hours with not less than C grade in each course.

2. A minimum grade point average (GPA) of 2.5 in every semester and a cumulative grade point average (CGPA) of at least 3.0.

3. Completion of oral defense of thesis with satisfactory grade.

4. The maximum time allowed to complete the degree is five years from the date of admission into the program.
Failures and Dismissal

A student must maintain a semester grade point average (GPA) of 2.5 or above at the end of each semester failing which the student will be subject to dismissal from the program. There will be no re-examination for any student who is absent during the final assessment. Absence will render the status of the student’s course as incomplete.