SYLLABUS
Masters of Science in Forestry
2024

Tribhuvan University
Institute of Forestry
Kirtipur,
Kathmandu

FOREWORD

The Master of Science degree in Forestry, conferred by Tribhuvan University, stands as an advanced educational milestone designed to cultivate adept professionals in the field of forestry. This academic journey has been shaped by a commitment to excellence, and the number of curriculum revisions ensure that the course is aligned with the changing context. The curriculum overhaul is an integral part of the Institute of Forestry's (IOF) comprehensive review process. This revision aims to fortify the students' proficiency in applying fundamental principles of forestry and natural resource science to address contemporary challenges in professional practice.

At the heart of this revision process lies a collaborative spirit, with experts and stakeholders engaged at both national and international levels. Leveraging their insights, the curriculum has been crafted aiming that equips students to confront the evolving issues within forest science. The courses introduced are strategically designed to tackle the myriad challenges associated with Forest management, particularly in the face of escalating global changes. The envisioned outcome is to empower students with analytical skills, decision-making abilities, and the capacity to address the multifaceted nature of problems inherent in the field of forestry, while balancing the trade-off between ecological and societal needs.

Embarking on this new academic journey, the subjects are identified considering these multiple roles of forestry, where the subject committees and faculty board of the IOF took a leadership role in shaping it. Moreover, many individuals and institutions have contributed directly and indirectly to bring this curriculum to this shape. This is also an outcome of the consultative processes carried out at different levels. I express my sincere thanks to internal and external experts, subject committee chairs and members, and the Faculty Board for their kind cooperation and contributions. Special appreciation is extended to the ALIGN project WWF Nepal for their financial support in the preparation of the syllabus. Further, I would like to extend my special thanks to the Academic Council of Tribhuvan University for approving this curriculum. I appreciate the contribution of curriculum revision committee members Associate Prof. Dr. Sony Baral, Prof. Dr. Krishna Raj Tiwari, Prof. Dr. Rajesh Kumar Rai, Associate Prof. Dr. Narayan Prasad Gautam and Associate Prof. Dr. Menuka Maharjan, IOF for revising the M.Sc. syllabus with leaving no stone unturn.

I am confident that our students will serve as warriors for addressing the planetary crisis, that we are now facing, such as global climate change, biodiversity losses and environmental issues. Moreover, they will serve in the sustainable management of the global commons. As we step into this renewed academic chapter, we remain committed to upholding the highest standards of education and fostering a learning environment that prepares our students to be leaders and innovators in their respective fields.

Prof. Bir Bahadur Khanal Chhetri, PhD
Dean

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INTRODUCTION

Forestry is currently grappling with a confluence of challenges, including climate change, biodiversity loss, and the need for sustainable production and development on a global scale. This has led to an escalating level of pressure and threats on forests, which serve as pivotal entities in addressing numerous national and international challenges. The role of the academics is pivotal in addressing these global challenges. In response to the evolving demands of the market, the Master's program in forestry has been revised to enhance the skills of students and preparing them to navigate the diverse aspects of technical, field, and policy dimensions within the forestry sector. The program is designed not only to equip students with the knowledge necessary to address complex national and international forest challenges but also to empower them to seek, negotiate, and implement solutions in the face of a rapidly changing world.

The Institute of Forestry (IOF) aims to provide high quality education, developing critical thinking skills, and preparing students for their future careers in forestry and natural resources sectors. This is achieved through a multifaceted approach encompassing extensive field research, a dynamic forest lab, an on-campus museum, and impactful outreach programs. Established in 1947 AD, the IOF is the pioneer institute dedicated to imparting comprehensive knowledge and technical expertise in Forestry and allied sectors. As a hub for advanced education in forestry, the Institute of Forestry continues to play a pivotal role in developing skilled professionals and the sustainable management of Nepal's rich natural resources.

The Institute of Forestry has been offering academic degrees, Bachelor's in forestry, Masters and PhD programs in various fields of Forest Science, including Forestry; Community Forestry; Wildlife Management and Biodiversity Conservation; Mountain Environment and Development Studies; Watershed Management; and Natural Resource Management and Rural Development. The IOF periodically revises the curriculum, engaging academicians, development practitioners, researchers, and policymakers to provide students with the current state of knowledge on forestry sciences and make them competent to address the emerging issues and challenges in the forestry sector. The M.Sc. programs have been designed as per the increasing needs of the diverse areas and expanding context and career landscape at the national and international levels. Considering the forest is key to addressing many of these national and international challenges diverse Master programs have been introduced and revised as per the need.

The updated course streamlines the learning process by introducing a unified first-year curriculum, ensuring that students, regardless of their specialization (Forestry, Wildlife Management and Biodiversity Conservation, Natural Resources Management and Rural Development, Watershed Management, Mountain Environment and Development Studies, Community Forestry), develop a foundational understanding of crucial interdisciplinary concepts against the backdrop of pressing issues such as policy, forestry, climate change, biodiversity loss, and pollution. The program aims to impart knowledge and skills on forest management, ethical considerations, and the interconnection of human dynamics with nature. The program will also fulfill the following specific objectives:

- To empower individuals with technical expertise capable of delivering forestry services across diverse sectors,
- To develop proficiency in practical skills such as risk assessment, and problem-solving
- Building capacity to make ethical decisions in forestry

For this program adopts a pragmatic, field-based teaching approach, emphasizing applied learning structures. Our graduates will be equipped with a versatile skill set that positions them to ascend in government service, attain notable success in academic pursuits, establish themselves as successful entrepreneurs, and secure high-profile green jobs. The comprehensive academic journey will prepare them to thrive in various career paths and to contribute significantly to their chosen fields.

PROGRAM DURATION AND ACADEMIC SESSION

The MSc Forestry program will span two academic years, comprising a total of four semesters. The First semester focuses on the theoretical aspects of forest and natural resource management. The second semester emphasized on tools and techniques required for data collection and analysis. The Third semester focuses on forest ecology, silviculture, forest management and utilization. The Fourth semester is allocated for conducting research and sharing their findings.

ADMISSION REQUIREMENTS

The candidate must hold a Bachelor of Science in Forestry degree, which should be a minimum of four years in duration, obtained from either Tribhuvan University or any institution acknowledged by Tribhuvan University.

COURSE CODE AND CODE NUMBERS

The course code provided in this curriculum comprises a concise representation of the Subject Matter Committee, including a number and additional information enclosed in parentheses. The initial abbreviated text within the course code signifies the specific Subject Committee category to which the course belongs. The abbreviations corresponding to the course codes are outlined below:

PWM: Park Recreation and Wildlife Management
SFB: Silviculture and Forest Biology
SFM: Social Forestry and Forest Management
WME: Watershed Management
FPE: Forest Products and Engineering
BSH: Basic Science and Humanities

Students have the option to take any of the courses as extra electives in addition to the required courses for their enrolled Master's degree program.

ADMISSION, EVALUATION AND AWARD OF DEGREE

Applicants who have secured a minimum of 45% marks in aggregate in Bachelor of Science in Forestry or an equivalent degree are eligible to apply for admission to respective Master's level programs. All students must appear in the entrance examination administered by the Examination Section of the IOF and are selected for admission based on their merit score. Both academic achievements and performance in the entrance examination will play a crucial role in the admission process.

Evaluation and Examination System

Each semester, students undergo a comprehensive evaluation, encompassing both internal and external assessments. To pass the examination, students are required to secure a minimum of 50% marks in the final external (final exam) and internal (practical and assessments) examinations separately. The grading system allocates 40% of the marks to internal and 60% to the external (final) exams.

The administration of internal examination marks falls under the responsibility of the respective course coordinator, ensuring transparency and accuracy in the assessment process. However, the evaluation culminates in the final written examination, scheduled at the end of the semester. It is imperative to note that students must fulfill the prerequisite of passing the internal to be eligible to sit for the final examinations. In case of students failing to meet the passing criteria in the regular semester examination, they are provided with an opportunity to appear in a make-up examination. Nevertheless, students must adhere to the protocol of filling out the examination form for the respective semester.

The internal marks are given by the responsible course teacher based upon the assessment of attendance tracking, and various tasks such as fieldwork, laboratory exercises, term papers, class presentations, report writing, project work, and home assignments. The assessment process is undertaken by the faculty responsible for each course, who provide clear and detailed evaluation criteria to students well in advance. This proactive communication ensures students to understand and meet the expectations set forth in their courses effectively. Further, the Dean's office will form a committee to evaluate the completion of internal assessment and the marks given by the responsible course teacher. The committee will be responsible for reviewing the internal assignments and carried out while teaching the course and the evaluation criteria for the internal evaluation set by the course responsible teacher as per the nature and objective of the course. The committee will also be authorized to change or not to change the marks given by the internal evaluator if deemed necessary. Finally, the committee will submit report together with the marks of all subject of the semester to the Dean's Office stating whether or not the courses were taught and the evaluation were done in a scientific manner.

The student's thesis will undergo evaluation by the Research Assessment Committee (RAC), coordinated by the main supervisor alongside internal and external experts. The internal expert will be selected by the respective campus, while the external expert will be chosen by the exam control division, ensuring alignment with the subject area's relevance.

Attendance Requirement

A student must attend at least 80% of classes in each subject. Attendance carries 20% marks on the internal assessment. Failure to fulfill the attendance requirement by a student may result in his/her disqualification to appear in the final examination. But, in specific cases (seriously ill, out of control situation) student having 70% attendance are allowed to appear the final examination. In this case, student should submit medical certificate for seriously ill, and certificate of the concerned authority in other cases.

Academic Transcript and Grading System

After the successful completion of all the requirements prescribed by the course curriculum, a student will be eligible for the award of an M.Sc. degree in the respective programs. An academic transcript is issued by the Controller of Examination of Tribhuvan University to students who have fulfilled all requirements. The academic standard of students is based on the cumulative percentage of marks secured in all examinations. The IOF adopted the grading system indicated in credit transfer, grading system, and the academic transcript study report of 2020 approved by TU Academic Council decision no 64 on 2078/1/14 [Table 1].

Table 1: Grading System for M.Sc Program

Grade	**GPA**	**Grading Scale (in %)**	**Performance**
A	4.0	90-100	Outstanding
A-	3.7	80- less than 90	Excellent
B+	3.3	70-less than 80	Very good
B	3.0	60- less than 70	Good
B-	2.7	50 -less than 60	Satisfactory
F	0.0	Less than 50	Fail

In this system, a student has to receive a minimum of 2.7 GPA or letter "B-" grade to pass each course.

In every semester, students will be given Semester Grade Point Average (SGPA) using the following calculation

$$\text{SGPA} = \frac{Total\ Grade\ Point\ earned\ in\ a\ semester}{Total\ Number\ of\ credit\ registered\ in\ a\ semester}$$

Based on the grades earned in each semester, Cumulative Grade Point Average (CGPA) will be calculated as follows:

$$\text{CGPA} = \frac{Total\ Grade\ Point\ earned}{Total\ Number\ of\ credits\ completed}$$

SEMESTER-WISE COURSE BREAKDOWN

COURSE DESCRIPTIONS

SEMESTER I

COURSE TITLE: FORESTS AND ENVIRONMENT POLICY

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFM 501	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: Forest and other environmental policies play an important role in sustainable resource management. This course is designed to introduce students to the contextual understanding of policies that have shaped the management of renewable resources (i.e., forest, wildlife, water, etc.) in Nepal and beyond. Throughout the course, students will learn ideas behind natural resource policies and try to understand their role in broader natural resource decision-making.

OBJECTIVES: The objectives of this course are to:

- To facilitate student learning in forest and environmental policymaking and be able to apply this understanding to case studies of environmental and natural resource policy issues.
- To familiarize students with the development of key national and international policies for natural resources and environmental sustainability.
- To familiarize students with the organizational and administrative structure and policy-making processes of the major federal natural resource management agencies in Nepal.
- To facilitate students in their ability to critique and evaluate policy processes and policy outcomes in the context of emerging market issues and changing natural resource conditions.

LEARNING OUTCOMES: Upon the completion of this course, the students will be able to

- Have a clear understanding of the evolution and administrative functionalities of major forest and environmental policies in Nepal.
- Understand the public policy formulation process in national and international contexts.
- Understand the evolution of environmentalism in national and international contexts.
- Be familiar with the various policies and regulations in Nepal pertaining to environment and natural resources.

COURSE CONTENTS

UNIT 1: INTRODUCTION TO FOREST AND ENVIRONMENTAL POLICY (6)

1.1 Natural Resource Management and Politics
1.2 Importance of Public Policy
1.3 Evolution of Environmental Policy (forest, watershed, wildlife)
1.4 Global Challenges in Natural Resource Management / Planetary Crisis
1.5 Tragedy of the Commons

1.6 Externalities and Market Failure

UNIT 2: POLICY PROCESS MODELS (8)

2.1 Economic, Political, and Ethical Perspectives on Environmental Policy
2.2 Natural Resource Policy as a Process
2.3 Public (forest/watershed/wildlife) Policy Formulation Process in Nepal
2.4 Environmental Sustainability and Natural Resource Policies
2.5 Criteria for Policy Analysis

UNIT 3: ENVIRONMENTALISM AND ENVIRONMENTAL POLICIES (8)

3.1 Environmentalism and its Impact on Policies
3.2 Theoretical Foundation: Ecocentrism, Anthropocentrism, and Deep Ecology
3.3 Emergence of Environmental Impact Assessment as a Policy Tool
3.4 Endangered Species Conservation and International Trade

UNIT 4: INTERNATIONAL CONSERVATION POLICIES (4)

4.1 International Convention Joining and Withdrawal Process
4.2 Earth Summit 1992 and its Outcome Conventions
4.3 International Climate Agreements and their Effectiveness

UNIT 5: SECTORAL POLICIES IN NEPAL (6)

5.1 Constitutional Provisions Related to Natural Resources
5.2 Sectoral Policies (Other) and Natural Resource Conservation
5.3 Synergies in Natural Resource Related Policies (Climate, Environmental, Forests, Watershed, Wildlife)
5.4 Natural Resource Revenue Sharing Mechanism

PRACTICAL (16)

Contents	**Equipment/tools**	**Methodology/methods**	**Link to Unit(s)**
History of policies (Sectoral) in Nepal	Literature	Literature Review and Presentation	Unit 1, 4
Policy analysis of Nepal Forest/Environment/Watershed/ climate policy (Outcomes)	Policy document	Group work / Report	Unit 2
Improving EIA in Nepal	Expert Consultation	Group work / Critiques and Suggestions	Unit 3
Status and Challenges of International Treaties in Nepal	Literature, Expert Consultation	Group work/ Report	Unit 5
Policies in Nepal	Literature	Review / Class Discussion	Unit 6

KEY REFERENCES

Unit 1

1. Askari, H., Iqbal, Z., & Mirakhor, A. (2014). Significance of Public Policy. In: *Challenges in economic and financial policy formulation: An Islamic perspective*. New York: Palgrave Macmillan.
2. Dolzer, R. (2001). Environmental Policy. *International Encyclopedia of the Social & Behaviroral Sciences.* 4638-4644.
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4. Mondal, S., & Palit, D. (2022). Challenges in natural resource management for ecological sustainability. In *Natural Resources Conservation and Advances for Sustainability* (pp. 29-59). Elsevier.
5. Shmelev, S. E., & Shmelev, S. E. (2012). Macroeconomy: Market Failures and Externalities: What Can Be Done. *Ecological Economics: Sustainability in Practice*, 75-85.
6. Verran, H. (2009). Natural Resource Management's' Nature'and Its Politics. *Communication, Politics & Culture*, *42*(1), 3-18.

Unit 2

1. Bromley, D. W., & Paavola, J. (2002). Economics, ethics and environmental policy. *Economics, ethics, and environmental policy: contested choices*, 261-276.
2. Cubbage, F. W., Laughlin, J. O' & Peterson, M. N. (2017). Natural Resource Policy. Waveland Press, Inc. 10-digit ISBN: 1-4786-2965-X; 13-digit ISBN: 978-1-4786-2955-9.
3. de Anguita, P. M., Alonso, E., & Martin, M. A. (2008). Environmental economic, political and ethical integration in a common decision-making framework. *Journal of environmental management*, *88*(1), 154-164.
4. Gautam, M. S., & Pokhrel, B. (2011). Foreign Aid and Public Policy Process in Nepal A Case of Forestry and Local Governance. *Kathmandu: South Asia Institute of Advance Studies*.
5. Greco, S., & Munda, G. (2017). Multiple criteria evaluations in environmental policy analysis. In *Routledge handbook of ecological economics* (pp. 311-320). Routledge.

Unit 3

1. Balistrieri, Carlo A. (1993). CITES: The ESA and international trade. *Natural Resources & Environment* 8, no. 1: 33-76.
2. Bullard, R. D., & Johnson, G. S. (2000). Environmentalism and public policy: Environmental justice: Grassroots activism and its impact on public policy decision making. *Journal of social issues*, *56*(3), 555-578.
3. Grey, W. (1993). Anthropocentrism and deep ecology. *Australasian Journal of Philosophy*, *71*(4), 463-475.
4. Robinson, N. A. (1991). International trends in environmental impact assessment. *BC Envtl. Aff. L. Rev.*, *19*, 591.
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6. Sessions, G. (1988). Ecocentrism and The Greens: Deep Ecology and the Environmental Task. *The Trumpeter*, *5*(2).

Unit 4

1. Almer, C., & Winkler, R. (2017). Analyzing the effectiveness of international environmental policies: The case of the Kyoto Protocol. *Journal of Environmental Economics and Management*, *82*, 125-151.
2. Bang, G., Hovi, J., & Skodvin, T. (2016). The Paris Agreement: Short-term and long-term effectiveness. *Politics and Governance*, *4*(3), 209-218.
3. Parson, E. A., Haas, P. M., & Levy, M. A. (1992). A summary of the major documents signed at the Earth Summit and the Global Forum. *Environment: Science and Policy for Sustainable Development*, *34*(8), 12-36.
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5. Siebenhüner, B., & Suplie, J. (2005). Implementing the access and benefit-sharing provisions of the CBD: A case for institutional learning. *Ecological Economics, 53*(4), 507-522.
6. United Nations (1992). Agenda 21.
7. United Nations (1992). United Nations Framework Convention on Climate Change.
8. United Nations. (2015). Paris Agreement (Articles 20, 21, 28).

Unit 5

1. Constitution of Nepal (2015).
2. Nepal Kanun Kitab Byabastha Samiti (Acts – Land, Infrastructure, Mine, Industry, Hydropower).
3. National Natural Resource and Fiscal Commission Act.
4. National Natural Resource and Fiscal Commission. (2017). Recommendation on the Distribution of Royalties from Natural Resources Mobilization.

COURSE TITLE: NATURE AND SOCIETY

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFM 502	3	48 (32+16)	75 (45+30)

Note: 1 Credit= 16 Lecture Hours

SCOPE: This course covers key theoretical concepts and approaches in social sciences as they relate to understanding and describing the relationship between society and nature. It is intended to help students develop contemporary knowledge and practical skills in assessing and analyzing the causes and solutions of natural resource problems by integrating concepts and foundational theories in social science disciplines.

OBJECTIVES: The objectives of this course are to:

- Foster an understanding of the evolution of human-nature relationships
- Develop a deeper understanding of the complex dynamics of coupled human and natural systems
- Enhance knowledge regarding various social science theories in explaining and predicting human behavior in the context of natural resource management
- Develop a critical foundation for further research on human-nature interactions with using the concepts and skills of conservation social science

LEARNING OUTCOMES: Upon the completion of this course, the students are expected to be able to:

- Know a range of foundational theories in social science to explain and predict the interaction between humans and nature
- Understand the evolving complexity of human and natural systems, including disturbance and adaptation
- Identify and evaluate the importance of cultural and economic institutions in the sustainability of natural resources
- Become familiar with diverse ways human values, beliefs, and norms relate to their behavior toward nature and,
- Integrate ideas and practices from contemporary social science in planning, decision-making, and policy regarding sustainable management of natural resources.

COURSE CONTENTS

UNIT 1: FOUNDATIONS OF NATURE AND SOCIETY (5)

1.1 Human History and Nature
1.2 Equilibrium and Non-Equilibrium Ecology
1.3 Philosophical Foundation of Nature-Human Relationship (Eco-centric, Anthropocentric)
1.4 The Social Construction of Nature
1.5 Nature and Culture

UNIT 2: CHANGES, CHALLENGES, AND PARADIGM SHIFT IN CONSERVATION (6)

2.1 Anthropocene Biosphere
2.2 Planetary Boundaries
2.3 Limits to Growth
2.4 Ecological Modernization
2.5 Bright Green Environmentalism
2.6 Eco-centric vs Anthropocentric

UNIT 3: HUMAN NATURE INTERACTION (8)

3.1 Social-Ecological Systems
3.2 Common Property Regimes
3.3 The Community Capital Framework
3.4 Collective Actions and Impact
3.5 Intermediate Disturbance Hypothesis

UNIT 4: SOCIAL CONTEXT OF NATURE-BASED SERVICES (5)

4.1 The Worth of Nature to Humans
4.2 Ecosystem Marketplace as a Solution
4.3 Climate Change and Social Cost of Carbon
4.4 Opportunity Cost Approach in Conservation Priorities
4.5 Environmental Consumerism

UNIT 5: CULTURE AND WORLDVIEWS (8)

5.1 Drivers of Human Behaviors
5.1.1 Theory of Behavior
5.1.2 Value-Belief Norm Theory
5.2 Demographic Influences on Conservation Values
5.3 Nature-Culture/Indigenous People Relationship
5.4 Social Trust in Natural Resource Management

PRACTICAL (16)

Contents	**Equipment/tools**	**Methodology/methods**	**Link to Unit(s)**
Indigenous community (ethnic group) and nature relationship (Ethnicity/culture-wise group)	Literature review/ reading materials	Group discussion	Unit 1
Influence of human-nature Interaction on Nepal's Forest/environment/wildlife /Watershed Policy Development	Literature review	Group presentation	Unit 2
Social-ecological system	Field	A report on SES / Group	Unit 3

KEY REFERENCES

TEXT BOOK

1. Misiune, I., Depellegrin, D., & Egarter Vigl., L. (2022). *Human-Nature Interactions: Exploring Nature's Values Across Landscapes* (p. 438). Springer Nature.

Unit 1

1. Kai N. Lee., W. R. Freudenburg., and R. B. Howarth. (2013). *Humans in the Landscape: An Introduction to Environmental Studies*. Pages 258-86.
2. Meadows, D. H., Meadows, D. L., & Randers, J. (1993). Beyond the limits: An executive summary. *Bulletin of science, technology & society*, *13*(1), 3-14.
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Unit 2

1. Lee, K. N., Freudenburg, W., & Howarth, R. (2012). *Humans in the landscape: an introduction to environmental studies*. WW Norton & Company.
2. Neuman, R. P. (2005). Making political ecology (Human geography in the making). Taylor & Francis publisher.
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Unit 3

1. Ostrom, E., Burger, J., Field, C. B., Norgaard, R. B., & Policansky, D. (1999). Revisiting the commons: local lessons, global challenges. *science*, *284*(5412), 278-282.
2. Ginsburg, C., & Keene, S. (2020). At a crossroads: consequential trends in recognition of community-based forest tenure from 2002-2017. *China economic journal*, *13*(2), 223-248.
3. Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science* 24: 325(5939):419-22

Unit 4

1. Stern's review
2. Dasgupta Review
3. Westman, W. E. (1977). How Much Are Nature's Services Worth? *Science* 197: 960-964

4. Costanza, R., De Groot, R., Sutton, P., Van der Ploeg, S., Anderson, S. J., Kubiszewski, I., ... & Turner, R. K. (2014). Changes in the global value of ecosystem services. *Global environmental change*, *26*, 152-158.
5. Walker, J. L. (1984). Tall trees, people, and politics: The opportunity cost of Redwood National Park. *Contemporary Policy Issues* 5: 22-29.
6. Pizer, W., Adler, M., Aldy, J., Anthoff, D., Cropper, M., Gillingham, K., ... & Wiener, J. (2014). Using and improving the social cost of carbon. *Science*, *346*(6214), 1189-1190.
7. Schröter, M., Rusch, G. M., Barton, D. N., Blumentrath, S., & Nordén, B. (2014). Ecosystem services and opportunity costs shift spatial priorities for conserving forest biodiversity. *PLoS One*, *9*(11), e112557.
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9. Hartig, T., Mitchell, R., De Vries, S., & Frumkin, H. (2014). Nature and health. *Annual review of public health*, *35*, 207-228.

Unit 5

1. Morford, S., Parker, D., Rogers, H., Salituro, C., & Waldichuk, T. (2003). Culture, worldviews, communication styles, and conflict in forest management. *Journal of Ecosystems and Management*.
2. J. Vaske, Maureen P. Donnelly, Daniel R. Williams, Sandra Jonker, J. (2001). Demographic influences on environmental value orientations and normative beliefs about national forest management. *Society & Natural Resources*, *14*(9), 761-776.
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7. Vaske, J. J., Absher, J. D., & Bright, A. D. (2007). Salient value similarity, social trust and attitudes toward wildland fire management strategies. *Human Ecology Review*, 223-232.
8. Madden, F., & McQuinn, B. (2014). Conservation's blind spot: The case for conflict transformation in wildlife conservation. *Biological Conservation* 178: 97-106.
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COURSE TITLE: WATER-ENERGY-FOOD-ECOSYSTEM NEXUS

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
WME 503	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: Water, energy, land/food, and ecosystems (WEFE) are critical for nutrition and food security, healthy ecosystems, resilient economies, and sustainable development. Single disciplinary (or silo) approach has limitations to achieve the interconnected development goals (e.g., sustainable development goals) in inclusive manner whereas the nexus approach considers the interconnections among the sectors, quantifies synergies and trade-offs of an intervention, and also has the potential to serve as a climate change adaptation and human security solutions. However, governments, stakeholders, and investors are struggling to manage systems change in the WEFE nexus and ensure that the changes are robust under changing climate and evolving interactions among natural and human systems. In this context, this course starts with the context of natural resources under stress, introduces associated concepts, and then evolves into the system approach, nexus concept and principles, entry points for inclusion, system interactions, nexus assessment tools, nexus in practice and nexus future perspective. It includes theoretical sessions, assignments, practical/presentation sessions, and field studies. The course is divided into 5 chapters and 20 sub-chapters, with four sub-chapters in each chapter.

OBJECTIVES: This course aims for the following learning objectives

- To familiarize with the fundamentals of WEFE nexus in the context of natural resources management and climate change
- To enhance knowledge and skill in nexus assessment
- To provide exposure to practical cases and challenges for implementing WEFE nexus using context-specific and participatory approaches
- To deepen understanding of institutionalizing WEFE nexus
- To provide a future outlook of WEFE nexus as a sustainability agenda from people-centric lenses and Gender Equality, Disability and Social Inclusion (GEDSI) perspectives

LEARNING OUTCOMES: Upon the completion of this course, learners are expected to

- Internalize the nexus concept and apply as a solution in planning and designing natural resources development and management problems
- Develop interdisciplinary programs in a professional career with a focus on broader national goals rather than sector-specific goals
- Develop skills to engage with stakeholders to develop sustainable and participatory practices for WEFE nexus management
- Develop number of demonstrated cases of nexus solutions during professional practice and share in public domain

COURSE CONTENTS

UNIT 1: UNDERSTANDING OF NEXUS (6)

1.1 Stress in Natural Resources: Trends in Natural Resources Availability and Demand; Concept of Footprints (water, energy, and carbon footprints); Planetary Boundaries
1.2 System Approach: Understanding of a System and System Approach; Need of Integration Across Sectors; Evolution of the Nexus Thinking Approach (limits to growth, sustainability, and nexus)
1.3 WEFE Nexus: Concept, Principles, and Added Benefits
1.4 Entry Points for Inclusion in Nexus Interventions

UNIT 2: SYSTEM INTERACTION (6)

2.1 Water-Energy
2.2 Water-Food
2.3 Food-Energy
2.4 Interdependences and Inter-Linkages Across Multiple Systems (e.g., water, energy, food, ecosystem/biodiversity): Tradeoff and Synergies

UNIT 3: ASSESSMENT TOOLS (9)

3.1 Assessment Process and Information Flow: Steps, Actors, Location, and Sectors
3.2 Various Types of Tools and Data
3.3 FAO Rapid Appraisal Tools and WEF Nexus Tool 2.0 (including demonstration of tool)
3.4 Scenario Analysis and Practical Challenges: Evaluating Impacts in the Changed Context (institutional changes, climate/environmental/socio-economic changes, policy changes, etc.)

UNIT 4: NEXUS IN PRACTICE (6)

4.1 Dissecting Nexused Relationships on Existing Practices: Case Studies Highlighting Different Aspects of Nexus in Practice
4.2 Risks and Costs to Different Social Groups
4.3 Policy and Institutional Reforms
4.4 GEDSI and Indigenous Knowledge

UNIT 5: NEXUS FUTURE PERSPECTIVE (5)

5.1 Nexus Governance: Fundamentals of Governance and Nexus Governance; Frameworks for Governance Analysis; Improving Sectoral Governance and for Nexus Gains
5.2 Streamlining WEFE Nexus as a Common Agenda: Promoting Dialogue (between science, policy, practice/industry, private sector); Nexus Mainstreaming
5.3 Addressing Bottlenecks for Implementing Inclusive Solutions for WEFE Nexus Gains: Technical/Engineering Solutions; Nature-Based Solutions; Governance Solutions
5.4 Monitoring, Evaluation, Accountability and Learning (MEAL) Framework for Maximizing Nexus Gains

PRACTICAL (16)

- **Group assignment**: Divide the participants into different groups, each consisting of 3-5 persons. Ask the participants to identify one practical case that they are engaged with, characterize the WEFE nexus in that case, and then submit an assignment report as well as a presentation in class. There will be more discussions and inputs in the class from the instructor as well as other participants (beyond that particular group) to visualize the practical cases of the WEFE nexus. (4 hrs)

- **Assignment on application of FAO tool and WEFE nexus 2.0**: Based on data provided for a real or hypothetical case study for simulating WEFE nexus 2.0, and demonstration made in Chapter 3, students will prepare and submit a report on analysis of trade-offs and synergies and recommend potential solutions for minimizing tradeoffs and maximizing the synergies. (4 hrs)

- **Field study**: Students will join to 1-2 days field study in nearby areas to select 1-2 cases of different orientations (e.g., water, energy, food, ecosystem) but have nexuses relationships and dissect nexuses relationships in those cases, prepare a report and present in the class as post-field study report. (8 hrs)

Contents	**Equipment/ tools**	**Methodology/methods**	**Link to Unit(s)**
Dip dive nexuses relationship in existing approaches	Reference materials, Analytical thinking	Literature review to understand nexuses relationship Selected a couple of cases of different orientation Think critically to visualize interlinkages (trade-offs and synergies) Identify challenges and opportunities	Unit 1, 2, 4
Visualize nexus governance and explore the potential of WEFE nexus as a future security agenda	Field logistics, Reference materials, Analytical thinking	Field visits, Interaction with related stakeholders, Critical thinking to visualize interlinkages (trade-offs and synergies), and governance Identify the challenges faced and ways they are managed	Unit 5
Perspectives, cross-fertilization, and synthesis	Field data, Critical thinking	Analyses of field visit/data, Perspectives from different cases explored (e.g., management, policy, governance), Synthesis	Unit 1,2,3,4,5

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Unit 4

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COURSE TITLE: LANDSCAPE MANAGEMENT AND BIODIVERSITY CONSERVATION

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
PWM 504	3	48 (32+16)	75 (45+30)

Note: 1 Credit= 16 Lecture Hours

SCOPE: This course is designed to develop an understanding of issues on conservation landscape (hereafter referred to as landscape), landscape ecology, and biodiversity conservation. To prepare for careers in landscape and biodiversity conservation, students must attain academic skills and knowledge (both theoretical and technical) related to landscape management and biodiversity conservation. This course will help enrich student's understanding of biodiversity conservation at the landscape level. It enhances students' capacity to identify the prospects and challenges of biodiversity conservation and management in multiple-use landscapes.

OBJECTIVES: The objective of this course are to:

- Familiarize students with key technical terms related to landscape ecology, and biodiversity conservation.
- Enrich students' knowledge on landscape principles, and best conservation practices at landscape levels.
- Increase students' understanding on the causes and consequences of biodiversity loss in human-dominated landscapes.
- Enrich student's knowledge and skill in landscape planning, management, and biodiversity conservation.

LEARNING OUTCOMES: At the end of the course, students will be able

- To understand the basic landscape and biodiversity-related key terminologies
- To explore and understand landscape-level conservation values and challenges
- To learn the theories and principles related to landscape ecology
- In planning and implementation of landscape-level conservation initiatives
- To gain knowledge on biodiversity conservation and management in a human-dominated landscape

COURSE CONTENTS

UNIT 1: INTRODUCTION (6)

1.1 Landscape

1.1.1 Concept of Landscape and Landscape Ecology

1.1.2 Review of the Key Terms: Habitat, Eco-region, Biomes, Biodiversity Hotspots, Biodiversity Cold Spots, Habitat Fragmentation, Edge Effect, Corridors and Connectivity, Upstream-downstream Linkages, Landscape Integrity and Functions

1.1.3 Epistemology of the Landscape

1.1.3.1 The Nature of Landscape (material and conceptual)

1.1.3.2 Role of Landscape (domain, system, Unit)
1.1.3.3 Description of Landscape (ecological and cognitive)
1.1.4 Landscape Functions and Dynamics: Linkages with Species and Human Culture (IT/TK)

1.2 Biodiversity
1.2.1 Components of Biodiversity (genetic diversity, species diversity, ecosystem diversity, functional diversity)
1.2.2 Species Richness Over Geological Time Scale (rates of species formation, rates of species extinction, current pattern of species richness)
1.2.3 Values and Importance of Biodiversity (consumptive and non-consumptive use values, productive use values)
1.2.4 Patterns of Diversity (variation along climate and environment, variation in topography, geological age, and habitat)
1.2.5 Concept of Climate Change Refugia

UNIT 2: THEORIES AND MODELS IN LANDSCAPE ECOLOGY (6)

2.1 Driving Forces for Landscape Approach (international dialogue, conservation debate, innovations)
2.2 Landscape Stability Principle and CBD Malawi Principle 1995
2.3 Theories Incorporated in Landscape Ecology: Complexity Theory, Information Theory, Cognition and Autopoiesis Theory, Hierarchy Theory, Percolation Theory, Resource Theory
2.4 Landscape Ecology Models
2.4.1 Metapopulation Model
2.4.2 Source-sink Model
2.4.3 Island Biogeography Equilibrium

UNIT 3: PRINCIPLES FOR LANDSCAPE CONSERVATION, MANAGEMENT AND DESIGN (10)

3.1 Landscape Evaluation (creating and quantifying landscape patterns)
3.2 The Cultural (human-dominated) Landscape (interaction between natural and cultural landscapes, fragility of the cultural landscapes, cultural keystone species, landscape indicators, predictive landscape models)
3.3 Principles for Landscape Management
3.4 Landscape Ecology (landscape principles for natural reserves, disturbance regime, and reserve design indications, inter-refuge corridor design)
3.5 Principles of Landscape Classification (structural patch, functional patch, resource patch, habitat patch, corridor patch)
3.6 Landscape Level Conservation
3.7 Ecosystem Processes on Landscapes
3.8 Hierarchical Structure of the System and Biodiversity Conservation
3.9 The Landscape-level Species Conservation Approach
3.10 Transborder Landscape Conservation Approaches

UNIT 4: BIODIVERSITY CONSERVATION IN HUMAN-DOMINATED LANDSCAPE (4)

4.1 Biodiversity Conservation (with examples: in-situ and ex-situ)
4.2 Issues of Biodiversity Conservation
4.3 Urban Biodiversity Conservation Challenges
4.4 Green Infrastructure: Linking Landscape and Community
4.5 Roles of Ecosystem Management in Landscape Integrity: Protected Area: Core and Buffer Zone, Habitats Outside PAs, MAB (Man and Biosphere Reserve), Other Effective Area-Based Conservation Measure (OECM)
4.6 Importance of Landscape-level Biodiversity for Promoting Ecosystem Services and Local Livelihood in Developing Countries

UNIT 5: LANDSCAPE MANAGEMENT FOR BIODIVERSITY CONSERVATION (6)

5.1 Evolution and Practices of Landscape Management Models (global to national)
5.2 Conservation Landscapes of Nepal (TAL, CHAL, Kanchenjunga, SHL, and Kailash)
5.3 Prospects and Challenges of Landscape Management and Biodiversity Conservation
5.4 Land Use Planning and Conservation
5.5 Landscape Effects: in Individuals, Populations, and Organisms
5.6 Landscape Management Approaches and Strategies
  5.6.1 River Basin Approach
  5.6.2 North-South and East-West Landscape Approach
5.7 Case Studies
  5.7.1 Nepalese Model: Landscape (e.g., TAL, CHAL) and Corridor (e.g., Khata Corridor, Barandabhar Corridor)
  5.7.2 North American Model: (e.g., Yukon to Yellow stone)
  5.7.3 South African Model: (e.g., Great Limpopo Transfrontier Park)

PRACTICAL (16)

Contents	**Equipment/tools**	**Methodology/methods**	**Link to Unit (s)**
Measuring biodiversity	Silva compass, measuring tape, crown-densiometer, Abney level	3 days Field Diversity index (Simpson, Shannon Wiener) Observation, FGD, meetings with nearby community, KIS, Literature review, Report writing	Unit 1
Designing biodiversity conservation activities in the urban landscape	Reports, related literature		Unit 1, 3
Study linkages with species and human culture	Checklist		Unit 1
Review of CBD Malawi Principle1995	Related literature	Group presentation, report	Unit 2
Study on urban biodiversity challenges and threats ranking	Related literature	Excursion, Observation, Review of literature, Assessment by pairwise ranking, Report writing	Unit 4

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COURSE TITLE: NATURAL RESOURCE MANAGEMENT IN CHANGING ENVIRONMENT

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFM 505	3	48 (32+16)	75 (45+30)

Note: 1 Credit= 16 Lecture Hours

SCOPE: Changing the environment has jeopardized human-nature interaction, which has created a lose-lose scenario. This course focuses on understanding the changing context, its impacts on natural resources, and their mitigation, adaptation, and management strategies.

OBJECTIVES: The objectives of the course are to:

- To understand the changing context
- To understand key environmental issues and their effects on nature and society
- To assess appropriate strategies for natural resource management in the changing contexts
- To understand the issues in changing contexts in NRM in Nepal

LEARNING OUTCOMES: On completion of this course, students should be able to:

- Understand the changing contexts and its effects on natural resources
- Analyze the natural resource management related issues in the changing contexts,
- Develop a conceptual and practical understanding of strategies for natural resource use and management in the changing environmental conditions
- Apply the learned concepts to a natural resource management problem of particular interest to them.

COURSE CONTENTS

UNIT 1: UNDERSTANDING THE CHANGING CONTEXT (5)

1.1 Theoretical context – Change Theory

1.2 Global Environmental Changes: Climate Change, Land use and land cover change, Invasive Species

1.3 Social Changes- Demographic Shifts, Cultural Transformations, Technological Advancement, Urbanization, Gender Roles and Equality, Environmental Movement

1.4 Economic Changes – Technological Transformations, Globalization, Labor Market Change, Financial System, Environmental and Sustainable Practices, Income equality, Global Economic Shift

UNIT 2: EFFECTS OF CHANGING ENVIRONMENT ON NATURAL RESOURCES (7)

2.1 Effects on:

2.1.1 Water Resources – Glacier's Retreat, Precipitation Pattern, Sea Level, Spring, Rivers, Groundwater, Wetlands

2.1.2 Agricultural Resources– Agro-Biodiversity, Cropping Pattern, Pest and Diseases

2.1.3 Forest and Biodiversity– Shift in Habitat Ranges, Increased Wildfire, Invasive Alien Species
2.1.4 Wildlife
2.1.5 Rangelands
2.1.6 Landscape

2.2 Alteration of Human-Nature Interactions Due to Changing Context

UNIT 3: MITIGATION AND ADAPTATION STRATEGIES (5)

3.1 Sustainable Land and Water Management
3.2 Biodiversity Conservation and Restoration
3.3 Climate Resilient Infrastructure
3.4 Traditional Knowledge, Practices, and Technologies
3.5 Renewable Energy Transition

UNIT 4: ISSUES IN NRM IN CHANGING CONTEXT IN NEPAL (5)

4.1 Shift in Demand for Natural Resources
4.2 Land Abandonment
4.3 Human-Wildlife Conflict
4.4 Governance Conflict
4.5 Level of Participation in Natural Resource Management

UNIT 5: MANAGING NATURAL RESOURCES IN CHANGING ENVIRONMENT (10)

5.1 Ecological Principles and their Application to Natural Resource Management
5.2 Adaptive Management
5.3 Forest-Landscape Restoration
5.4 Invasive Species Management
5.5 Nature Based Solutions
5.6 Disturbance-based Ecosystem Management

PRACTICAL (16)

Contents	**Equipment/tools**	**Methodology/methods**	**Link to Unit(s)**
Drivers of changing context	Field /Checklist	Prepare a list of drivers and strategies to address them (Group work)	Unit 1, 2
Issues of NRM in Nepal and potential solutions	Literature review	Group / Class presentation	Unit 4
Enlisting mitigation/adaptation/management interventions in own locality	Interview (Telephone), Field observation	Individual - list of interventions	Unit 3, 4, 5

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Unit 4

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Unit 5

1. Bolte, A., Ammer, C., Löf, M., Nabuurs, G. J., Schall, P., & Spathelf, P. (2009). Adaptive forest management: a prerequisite for sustainable forestry in the face of climate change. *Sustainable forest management in a changing world: a European perspective*, 115-139.
2. von Gadow, K. (2008). *Managing forest ecosystems: the challenge of climate change* (p. 338). F. Bravo, V. LeMay, & R. Jandl (Eds.). New York: Springer.
3. Napreenko, M. G., Antsiferova, O. A., Aldushin, A. V., Samerkhanova, A. K., Aldushina, Y. K., Baranovskiy, P. N. & Konshu, E. V. (2021). New approaches to sustainable management of wetland and forest ecosystems as a response to changing socio-economic development contexts. *Innovations and Traditions for Sustainable Development*, 395-416.
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5. Kuuluvainen, T., Angelstam, P., Frelich, L., Jõgiste, K., Koivula, M., Kubota, Y., ... & Macdonald, E. (2021). Natural disturbance-based forest management: Moving beyond retention and continuous-cover forestry. *Frontiers in Forests and Global Change*, *4*, 629020.
6. Seddon, N., Chausson, A., Berry, P., Girardin, C. A., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B*, *375*(1794), 20190120

SEMESTER II

COURSE TITLE: GEOINFORMATICS FOR NRM

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
WME 551	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: This course is designed for the students having background on the foundation of GIS and Remote Sensing (RS). As the name says "Geoinformatics", the course contents aim to provide broader understanding on the application of GIS and Remote Sensing in NRM, with particular focus on developing skills on geospatial data extraction, analysis, modelling, management and effective communication for sharing the research widely. The course is based on both the theoretical and lab-based teaching/learning approaches.

OBJECTIVES: The course aims to provide advanced knowledge on applying geospatial technologies and remote sensing in natural resources management with the particular focus on emerging technologies for data analysis and cloud computing. The specific objectives of this course are to make students:

- Understand recent advancements/trends in Geoinformatics including theoretical and practical knowledge on the advanced concepts of RS & GIS in NRM.
- Enhance knowledge and practical skills on geo computation including exploratory data analysis and advanced concepts on spatial statistics.
- Develop a theoretical foundation on geomodelling and practical hands-on modelling related to NRM used cases.
- Provide overview and hands-on on emerging geospatial technologies for NRM like Machine Learning (ML) cloud computing with Google Earth Engine (GEE).

LEARNING OUTCOMES: After the completion of the course, the learners are expected to be able to:

- Develop a project and use advanced GIS/RS techniques for data collection to address specific problems in NRM
- Use geo-computational and statistical knowledge for data cleaning, analysis and management
- Use geospatial techniques for predictive modelling - NRM used cases.
- Use Cloud computing platform for efficient data analysis and visualization

COURSE CONTENTS

UNIT 1: OVERVIEW OF GEOINFORMATICS (6)

1.1 Fundamentals of Remote Sensing and GIS
1.2 Data to Geoinformation in NRM (data sources and availability, acquisition, interpretation and data quality issues)
1.3 RS and GIS Software (open source and commercial)
1.4 Recent Advancements/Trends in Geoinformatics
1.4.1 Mobile GIS, Drone-Based GIS, Citizen Science in GIS
1.4.2 Overview of Google Earth Engine, AI, and ML in NRM

UNIT 2: REMOTE SENSING SATELLITE AND SENSORS (8)

2.1 Sensors and Satellites (including orbits)
2.2 Scanning Systems
2.3 Optical Remote Sensing
2.4 Hyperspectral Remote Sensing
2.5 Radio Detection and Ranging (RADAR) Remote Sensing
2.6 Light Detection and Ranging (LIDAR) Remote Sensing

UNIT 3: GEOCOMPUTATION (6)

3.1 Digital Image Processing and Classification
3.2 Review Geospatial Interpolation (Kriging, / IDW, etc.)
3.3 Geospatial Statistics
3.4 Map Algebra and Raster Models Analysis
3.5 Terrain and Visibility Analysis

UNIT 4. GEOMODELLING (6)

4.1 Database Queries and Geo-Processing
4.2 Model Building for Geo-Processing
4.3 AHP Modelling
4.4 Geo-Visualization (cartographic representation)

UNIT 5. APPLICATION OF GEOSPATIAL TECHNOLOGIES (6)

5.1 Resource Assessment and Management.
5.2 Risk Assessment (forest fire, landslide)
5.3 Suitability Analysis
5.4 Analyzing Multi-Temporal Earth Observation Data

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit (s)
Image acquisition and processing	QGIS, /ArcGIS	Practical: 4hrs Demo and case presentation Student Engagement: 10hrs	Unit 1
Data cleaning and/map algebra and raster models/ surface and visibility analysis	QGIS/ ArcGIS	Practical: 4hrs One demo and other can be case presentation Student Engagement: 6hrs	Unit 3
Data queries/ Analysis and geo-visualization.	QGIS/ArcGIS	Practical: 3hrs one demo and other case presentation Student Engagement: 12hrs	Unit 4
Forest resource inventory and mapping/ indices (e.g., NDVI, NDSI, NDWI calculation)/Suitability/Time-series analysis	Cloud computing/GEE/ QGIS/ ArcGIS	Practical: 5hrs one demo and other case presentation Student Engagement: 20hrs	Unit 5
Project report and presentation		Review and report	

KEY REFERENCES

Unit 1

1. Duckham, M., Goodchild, M. F., & Worboys, M. (2003). Foundations of geographic information science. CRC Press.
2. Liu, J. G., & Mason, P. J. (2016). Image processing and GIS for remote sensing: techniques and applications. John Wiley & Sons.
3. Mclnerney, D., & Kempeneers, P. (2014). Open source geospatial tools: applications in earth observations. Earth Systems Data and Models, Springer.
4. Ma, X., Mookerjee, M., Hsu, L., & Hills, D. (Eds.). (2023). *Recent Advancement in Geoinformatics and Data Science* (Vol. 558). Geological Society of America.
5. Chuvieco, E. (2020). *Fundamentals of satellite remote sensing: An environmental approach*. CRC press.
6. Bajracharya, B., Thapa, R. B., & Matin, M. A. (2021), Earth observation science and applications for risk reduction and enhanced resilience in Hindu Kush Himalayan Region, Springer Nature, free access

Unit 2

1. Verbyla, D. L. (2022). *Satellite remote sensing of natural resources*. CRC Press.
2. Varshney, P. K., & Arora, M. K. (2004). *Advanced image processing techniques for remotely sensed hyperspectral data*. Springer Science & Business Media.
3. Richards, J. A. (2009). *Remote sensing with imaging radar* (Vol. 1, pp. 172-173).

Berlin/Heidelberg, Germany: Springer.
4. Liang, S., & Wang, J. (Eds.). (2019). Advanced remote sensing: terrestrial information extraction and applications. Academic Press.
5. Lu, B., Dao, P. D., Liu, J., He, Y., & Shang, J. (2020). Recent advances of hyperspectral imaging technology and applications in agriculture. Remote Sensing, 12(16), 2659.
6. Wang, G., & Weng, Q. (2013). *Remote sensing of natural resources*. CRC Press.
7. Flores-Anderson, A. I., Herndon, K. E., Thapa, R. B., & Cherrington, E. (2019). The SAR handbook: comprehensive methodologies for forest monitoring and biomass estimation (No. MSFC-E-DAA-TN67454).

Unit 3

1. Chun, Y., & Griffith, D. A. (2013). Spatial statistics and geostatistics: theory and applications for geographic information science and technology.
2. Getis, A., Anselin, L., Lea, A., Ferguson, M., & Miller, H. (2004). Spatial analysis and modeling in a GIS environment. In A research agenda for geographic information science (pp. 157-196). CRC Press. (Unit 4 too).

Unit 4 and 5

1. McClain, B. P. (2022). Python for Geospatial Data Analysis. " O'Reilly Media, Inc.".
2. Crooks, A., Malleson, N., Manley, E., & Heppenstall, A. (2015). Agent-based modeling and geographical information systems. Geocomputation: A Practical Primer. SAGE Publications Ltd, Thousand Oaks, CA, 63-77.
3. Pourghasemi, H. R., & Gokceoglu, C. (2019). Spatial modeling in GIS and R for earth and environmental sciences. Elsevier.
4. Wani, A. A., Bali, B. S., Ahmad, S., Nazir, U., & Meraj, G. (2022). Geospatial Modeling in Landslide Hazard Assessment: A Case Study along Bandipora-Srinagar Highway, NW Himalaya, J&K, India. In Geospatial Modeling for Environmental Management (pp. 113-125). CRC Press.
5. Wang, L., Yin, D. Z., & Caers, J. (2023). Data science for the geosciences. Cambridge University Press. (Unit 5 too).
6. Moseley, B., & Krischer, L. (2020). Machine learning and artificial intelligence in geosciences. Academic Press. (Unit 5 too).

COURSE TITLE: RESEARCH DESIGN AND SCIENTIFIC WRITING

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
BSH 552	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: The scope of this course is designed to imbue M.Sc. students with a scientific perspective, bridging the gap between overarching methodological principles and the intricacies of systematic inquiry into literature. It equips students with the skills needed to adeptly select and employ a range of research methods and tools for data collection. Through this course, students are equipped with the proficiency to thoughtfully select and deploy a diverse array of research methods and tools, ensuring a holistic approach to data collection. Moreover, the course offers a guided journey through the entire research process. From the initial stages of data collection to the in-depth analysis, students receive hands-on guidance that facilitates a comprehensive comprehension of each step. Furthermore, the course guides them through the entire process, from analysis to effectively articulating and presenting their research findings in their M.Sc. thesis.

OBJECTIVES: The objectives of this course are to:

- Acquire a profound understanding of diverse research types, encompassing their distinctive characteristics and ethical considerations.
- Comprehend both quantitative and qualitative research designs, mastering the art of employing various data collection methods to ensure the generation of high-quality data.
- Cultivate the ability to conduct thorough literature reviews, organizing information systematically to build a solid foundation for research endeavors.
- Hone skills in crafting meticulous and comprehensive research proposals, coupled with the proficiency to eloquently defend them during presentations, showcasing a mastery of the subject matter.
- Develop the capacity to articulate research findings effectively through the composition of clear and concise research reports, thesis documents, and scientific articles.

LEARNING OUTCOMES: Upon course completion, students will adeptly handle the intricacies of research methodology, understanding the critical connection between research questions and theoretical frameworks.

- Gain the capability to independently formulate and develop robust research proposals aligned with overarching research objectives.
- Acquire practical skills in data generation and analysis, utilizing diverse research methods and analytical tools to produce high-quality data and insightful interpretations.
- Navigate the complexities of an M.Sc. thesis, demonstrating proficiency in structuring and integrating research findings within theoretical frameworks.
- Demonstrate adeptness in manuscript composition and effectively communicating research findings with clarity and impact.

COURSE CONTENTS

UNIT 1: RESEARCH CONCEPTS (6)

1.1 Definition and Purpose
1.2 Research Paradigm (Normative, Explorative, Critical)
1.3 Research Types (Qualitative, Quantitative and Mixed)
1.4 Conceptual Framework of Research
1.5 Research Ethics: Informed Consent, Data Use & Confidentiality, Research Interpretation, Authorship and Publication, Plagiarism)

UNIT 2: RESEARCH DESIGN (10)

2.1 Meaning, Concept, Importance
2.2 Research Design: Components and Features
2.3 Characteristics
2.4 Types of Designs
- 2.4.1 Descriptive
- 2.4.2 Diagnostic
- 2.4.3 Experimental and Quasi-experimental
- 2.4.4 Exploratory Formulative
- 2.4.5 Case Study

2.5 Quantitative Research Design
- 2.5.1 Definition
- 2.5.2 Purpose
- 2.5.3 Analytical Framework
- 2.5.4 Data Collection Methods (sampling design and methods, survey)
- 2.5.5 Data Reliability and Validity
- 2.5.6 Data Analysis Methods (descriptive, inferential and casual analysis)

2.6 Qualitative Research Design
- 2.6.1 Definition
- 2.6.2 Purpose
- 2.6.3 Analytical Framework (use of theories)
- 2.6.4 Data Reliability and Validity
- 2.6.5 Data Collection Methods (observation, focus group discussion, semi-structured interview, content analysis)

UNIT 3: LITERATURE REVIEW AND ORGANIZATION (4)

3.1 Purpose and Types of Review
3.2 Review Organization
3.3 Citation and Reference Management

UNIT 4: RESEARCH PROPOSAL WRITING (4)

4.1 Research Proposal (purpose, components, and format)
4.2 Research Subject and Object
4.3 Formulating of Research Problem
4.4 Defining Research Objectives
4.5 Setting Research Hypothesis/Questions (meaning, definitions, nature, functions, importance, kinds, characteristics, formulation and testing)

4.6 Research Matrix
4.7 Research Site Selection
4.8 Respondent Selection
4.9 Data Collection Methods
4.10 Data Analysis
4.11 Work Plan
4.12 Budget Estimation

UNIT 5: THESIS WRITING AND PRESENTATION (4)

5.1 Purpose and Characteristics of the Good Thesis
5.2 Outline of the Thesis /Major Chapters or Sections
5.3 Data Analysis and Interpretation
5.4 Discussion on Findings (convergence and divergence Analysis)
5.5 Establishing a Causal Link Between Objective, Findings, Conclusion and Recommendations
5.6 Thesis Presentation: Slide Preparation, Table Graph, etc.

UNIT 6: SCIENTIFIC PAPER WRITING (4)

6.1 Step-wise Procedure
6.2 Selecting a Journal for Publication / Predatory
6.3 Communicating with the Journal Editor/Editorial Board
6.4 Peer Review Processes and Responding to Reviewer

PRACTICAL (16)

Contents	**Equipment/tools**	**Methodology/methods**	**Link to Unit(s)**
Research Design	Classwork	Group discussion and panel discussion	Unit 1 & 2
Scientific paper writing	4-5 person in a team review and write paper	Review paper/research paper on the contemporary subjects related to their field of study (able to identify knowledge gap, analyses and interpreted study findings)	Unit 3, 6
Research proposal	Literature review	Each student will write, submit and present a research proposal in their area of interest	Unit 4
Presentation	4-5 person in a team) will prepare and present their research findings	Prepare and present among students on their research findings and solicit comments and suggestions from students and faculties	Unit 3, 5, 6

KEY REFERENCES

Unit 1

1. Kumar, R. (2018). Research methodology: A step-by-step guide for beginners. *Research methodology*, 1-528.

2. Kerlinger, F. N. (1966). Foundations of behavioral research.
3. Mligo, E. S. (2016). *Introduction to research methods and report writing: A practical guide for students and researchers in social sciences and the humanities*. Wipf and Stock Publishers.

Unit 2

1. Bryman, A. (2012). Social Research Methods. Oxford University Press, New Delhi.
2. Cohen, L., Lawrence, M., & Morrison, K. (2005). Research Methods in Education, 5th edition. Oxford University Press, Oxford.
3. Denscombes, M. (2010). The Good Research Guide, For Small-Scale Social Research Projects. Open University Press, Maidenhead, Berkshire, UK.
4. Gregory, J., Miller, S., & Miller S. (2000). Science in Public: Communication, Culture and Credibility, Reprint edition. Perseus Book Group, New York.

Unit 3

1. Field, A. (2003). How to Design and Report Experiments. Sage Publications, Newbury Park, California.
2. Glass, D. (2006). Experimental Design for Biologists. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
3. Holliman, R., Whitelegg, L., Scanlon, E., Smidt, S., & Thomas, J. (2009). *Investigating science communication in the information age: Implications for public engagement and popular media*. Oxford University Press.
4. Singh, Y.K. (2006). Fundamental of Research Methodology and Statistics. New International (P) Limited, Publishers, New Delhi.

Unit 4

1. Soraya, M.C. & Cynthia, A.S. (2001). Proposal Writing. Sage Publications, Newbury Park, California.
2. Wallinman, N. (2006). Your Research Project: A Step-by-Step Guide for the First Time Researcher. Sage Publications, London.

Unit 5

1. Adu, P & Miles D. A. (2024). Dissertation Research Methods: A Step-by-Step Guide to Writing Up Your Research in the Social Sciences. Routledge, New York.

Unit 6

1. Thomas, C.G. (2021). Research Methodology and Scientific Writing (2nd eds). Springer. https://link.springer.com/book/10.1007/978-3-030-64865-7
2. Hoffmann, A.H. (2009). Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford, UK.
3. Mligo, E.S. (2016). Introduction to Research Methods and Report Writing. A Practical Guide for Students and Researchers in Social Sciences and the Humanities. Resource Publications, Eugene, Oregon.
4. Day, R. A., & Gastel, B. (2024). *How to write and publish a scientific paper*. Cambridge University Press.

COURSE TITLE: ADVANCED STATISTICS

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
BSH 553	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: The course will increase understanding on general concepts, meaning & use of statistics, and develop basic skills for computing & interpreting social and bio-physical data, and their applications using computer software in applied research. More importantly, the course aims to help M.Sc. students in selecting and use of different regression models in forestry research.

OBJECTIVES: The objectives of this course are to:

- Demonstrate the concepts of descriptive statistical measures, probability distribution and their uses in forestry research.
- Demonstrate basic concepts of hypothesis testing and experimental designs.
- Learn different types of parametric and non-parametric tests and use them in forestry research.
- Understand correlation and regression analysis and apply different types of regression models in forestry research and interpretation of results.
- Understand the concept of factor and discriminant analysis and develop skills for computation.

LEARNING OUTCOMES: Upon the completion of this course students will be able to

- Demonstrate the ability to understand the different types of variables and data
- Understand the appropriate use of statistical analysis
- Develop basic skills for computing & interpreting the data and their applications using computer software in applied forestry research.

COURSE CONTENTS

UNIT 1: INTRODUCTION (4)

Review**:** Data, Variables and Scale of Measurement, Population and Sample, Central Tendency and Dispersion, Sampling Techniques

UNIT 2: PROBABILITY DISTRIBUTIONS (4)

Review of Binomial, Poisson and Normal Probability Distribution, and their Applications

UNIT 3: ESTIMATION AND TESTING OF HYPOTHESIS (4)

Point estimation, Interval Estimation; t-test, z-test, Non-Parametric Tests: Chi-square Test, Median Test, Mann Whitney u-test, Kruskal Wallis test, Friedman ANOVA, Wilcoxon Sign Rank Tests

UNIT 4: ANALYSIS OF VARIANCE AND EXPERIMENTAL DESIGNS (6)

One-way and two-way ANOVA, Simple and Factorial Designs

UNIT 5: CORRELATION AND REGRESSION ANALYSIS (10)

Correlation Analysis, Ordinary Least Square Regression Models, Regression with Dummy Variables, Probit, Logit, Ordered Logit and Probit, MNL

UNIT 6: MULTIVARIATE ANALYSIS (4)

Principal Component Analysis (PCA), Factor Analysis, Cluster and Discriminant Function Analysis

PRACTICAL (16)

Contents	**Equipment/tools**	**Methodology/methods**	**Link to Unit(s)**
Data entry, coding, and editing in statistical software	Computer	Use of the questionnaire/ data	Unit 1
Computation of frequency distribution, diagram, and graphs, descriptive measures and their interpretations	With appropriate software	Using student's own or the given data	Unit 1
Testing of different types of hypotheses: T–tests. F-test etc.	With appropriate software	Using student's own or the given data	Unit 2, 3
Use of different non-parametric tests and their interpretations	With appropriate software	Using student's own or the given data	Unit 3, 4
Linear regression models and testing assumptions: Normality, Multicollinearity	With appropriate software	Using student's own or the given data	Unit 5
heteroscedasticity and auto-correlation; analysis of residuals	With appropriate software	Using student's own or the given data	Unit 5
Fitting of the logit, Probit, ordered logit, multinominal logit regression models and their interpretations	With appropriate software	Using student's own or the given data	Unit 5
Principal component analysis	With appropriate software	Using student's own or the given data	Unit 6

KEY REFERENCES

Unit 1

1. Shrestha, S. & Silwal D.P. (2003). Statistical Methods in Management. Taleju Prakashan, Bhotahity Kathmandu.

Unit 2

1. Gupta, S. C., & Kapoor, V.K. (1994). Fundamentals of Mathematical Statistics, 4th edition. Sultan Chand & Sons; 23, Daryagunj, Delhi.

Unit 3

1. Levine, D. M., & Stephan, D. F. (2009). *Even you can learn statistics: A guide for everyone who has ever been afraid of statistics*. FT Press.
2. Shrestha, S. & Silwal, D.P. (2003). Statistical Methods in Management. Taleju Prakashan, Bhotahity Kathmandu.
3. Triola, M. F., Goodman, W. M., Law, R., & Labute, G. (2004). *Elementary statistics* (p. 794). Boston: Pearson/Addison-Wesley.

Unit 4

1. FAO (1999). A Statistical Manual for Forestry Research. Forestry research support program, for Asia and the Pacific, Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific, Bangkok.
2. Nargundkar, R. (2008). Marketing Research: Text and Cases- Third edition. Tata McGraw-Hill Publishing Company Limited, NEW DELHI

Unit 5

1. FAO (1999). A Statistical Manual for Forestry Research. Forestry research support program, for Asia and the Pacific, Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific, Bangkok.
2. Levine, D. M., & Stephan, D. F. (2009). *Even you can learn statistics: A guide for everyone who has ever been afraid of statistics*. FT Press
3. Snedecor, G.W., & Cochran, W.G. (1994). Statistical Methods, eighth edition. Iowa State University Press, Ames Iowa.

Unit 6

1. FAO (1999). A Statistical Manual For Forestry Research. Forestry research support program, for Asia and the Pacific, Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific, Bangkok.
2. Levine, D. M., & Stephan, D. F. (2009). *Even you can learn statistics: A guide for everyone who has ever been afraid of statistics*. FT Press
2. Nargundkar, R. (2008). Marketing Research: Text and Cases- Third edition. Tata McGraw-Hill Publishing Company Limited, NEW DELHI

COURSE TITLE: NATURAL RESOURCE ECONOMICS

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFM 554	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: This course focuses on the concept of both theoretical and empirical evaluation of natural resources (forests, biodiversity, and water) pertaining to management. It includes subjects related to the time value of money, evaluation of a natural resource management project from an economic perspective, application of different valuation techniques to estimate the non-market benefits obtained from an ecosystem, practice of ecosystem service market, and green economy promotion for strong sustainability. Basically, it aims to capacitate students to analyze the problems and practices prevailing in the natural resource management sector from an economic perspective.

OBJECTIVES: The general objective of this course is to train students to promote economically viable natural resource management. Specific objectives are to:

- Enable students to understand and practice economic evaluation of natural resource management projects
- Enable students to estimate non-market benefits received from ecosystems
- Understand the importance of the ecosystem service market
- Prepare strategies for green economy promotion towards sustainable development

LEARNING OUTCOMES: After the completion of this course, students will be able to

- Understand and analyze the existing problems associated to natural resource management from the economic perspective
- Apply different economic evaluation tools in natural resource management
- Estimate non market benefits of ecosystem services and provide policy feedback for its proper management
- Practice activities for green financing promotion and support for green accounting of natural resource

COURSE CONTENTS

UNIT 1: INCORPORATING ENVIRONMENT INTO THE ECONOMIC SYSTEM (4)

1.1 Ecological Economics vs Environmental Economics
1.2 Economy-Environment Systems
1.3 Modelling Economy-Environment Interactions

UNIT 2: VALUATION OF ECOSYSTEM SERVICES (12)

2.1 Concept of Valuing the Ecosystem Services
2.2 Valuation Techniques
    2.2.1 Direct Market Approach
        2.2.1.1 Market Price Method

2.2.1.2 Production Function Approach
2.2.1.3 Cost-based Approach
2.2.2 Non-Market Based Valuation Techniques
2.2.2.1 Contingent Valuation
2.2.2.2 Travel Cost Method
2.2.2.3 Hedonic Price Method

UNIT 3: BENEFIT-COST ANALYSIS (8)

3.1 The Foundations of Benefit-Cost Analysis
3.2 Steps of Benefit-Cost Analysis
3.3 Time Value of Money (Discounting and Compounding, One-time payment, Annual Payment and Perpetual, Periodic Payment and Perpetuity)
3.4 Decision Criteria (Net Present Value, Benefit-Cost Ratio, Internal Rate of Return)
3.5 Sensitivity Analysis

UNIT 4: ECOSYSTEM SERVICES MARKET (4)

4.1 Financing Green and Greening Financing
4.2 Payment for Ecosystem Services
4.3 Forest Carbon Offset and Market
4.4 Biodiversity Offsets

UNIT 5: ENVIRONMENT AND SUSTAINABLE DEVELOPMENT (4)

5.1 Concept of Weak and Strong Sustainability
5.2 Sustainable Accounting (Green accounting): System of National Accounting (SNA) and System of Environmental Economics Accounting (SEEA)

PRACTICAL (16)

Contents	**Equipment/tools**	**Methodology/methods**	**Link to Unit(s)**
Natural Resources	Questionnaire, Excel, Data	Contingent Valuation Method	Unit 1, 2
Recreation areas such as protected areas/wetlands	Questionnaire, Excel, Data	Travel Cost Method	Unit 1,2
Evaluation of an environmental project/ Opportunity cost of carbon	Excel, Data	Benefit-cost analysis	Unit 3
Financing solutions	Peer-reviewed papers	Group presentation	Unit 4
SEEA of protected area/ CF	Peer-reviewed papers	Class Room discussion	Unit 5
Nature as an Input	Data, Excel	Production Function Approach	Unit 2

KEY REFERENCES

Unit 1

1. Adger, W. N. (2014). Environmental and ecological economics. In *Environmental science for environmental management* (pp. 93-118). Routledge.
2. Asafu-Adjaye, J. (2005). *Environmental economics for non-economists: techniques and policies for sustainable development*. World Scientific Publishing Company. (Chapter 2)
3. Venkatachalam, L. (2007). Environmental economics and ecological economics: Where they can converge? *Ecological economics*, *61*(2-3), 550-558.
4. Shmelev, S. E., & Shmelev, S. E. (2012). The economic system and the environment. Ecological Economics: Sustainability in Practice, 3-18.

Unit 2

1. Abdullah, S., Markandya, A., & Nunes, P. A. L. D. (2011). Introduction to economic valuation methods. Research tools in natural resource and environmental economics, 5, 143-187.
2. Asafu-Adjaye, J. (2005). Environmental economics for non-economists: techniques and policies for sustainable development. World Scientific Publishing Company. (Unit 5)
3. Chee, Y. E. (2004). An ecological perspective on the valuation of ecosystem services. *Biological conservation*, *120*(4), 549-565.
4. Vincent, J. R. (2008). *Environment as a production input: a tutorial*. SANDEE, Kathmandu, NP.

Unit 3

1. Asafu-Adjaye, J. (2005). *Environmental economics for non-economists: techniques and policies for sustainable development*. World Scientific Publishing Company. (Unit 6)
2. Hanley, N., Barbier, E. B., & Barbier, E. (2009). *Pricing nature: cost-benefit analysis and environmental policy*. Edward Elgar Publishing.
3. Sunstein, C. R. (2005). Cost-benefit analysis and the environment. *Ethics*, *115*(2), 351-385.

Unit 4

1. Brears, R. C. (2022). Financing Nature-Based Solutions. In Financing Nature-Based Solutions: Exploring Public, Private, and Blended Finance Models and Case Studies (pp. 29-50). Cham: Springer International Publishing.
2. Jack, B. K., Kousky, C., & Sims, K. R. (2008). Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms. *Proceedings of the national Academy of Sciences*, *105*(28), 9465-9470.
3. Bull, J. W., Suttle, K. B., Gordon, A., Singh, N. J., & Milner-Gulland, E. J. (2013). Biodiversity offsets in theory and practice. *Oryx*, *47*(3), 369-380.
4. Kinzig, A. P., Perrings, C., Chapin Iii, F. S., Polasky, S., Smith, V. K., Tilman, D., & Turner, B. L. (2011). Paying for ecosystem services—promise and peril. *Science*, *334*(6056), 603-604.
5. van Kooten, G. C. (2017). Forest carbon offsets and carbon emissions trading: Problems of contracting. *Forest Policy and Economics*, *75*, 83-88.

Unit 5

1. Asafu-Adjaye, J. (2005). *Environmental economics for non-economists: techniques and policies for sustainable development*. World Scientific Publishing Company. (Unit 12)
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COURSE TITLE: FOREST BIOMETRICS

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFM 555	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: This course covers the understanding of Forest Biometrics and detailed procedures for the development of volume, biomass, and taper equations. Further, it highlights the concept and detailed procedures for the development of different forms and approaches of forest growth and yield modelling. This course also covers the concept of dendrochronology, its measurement and analysis procedures, and applications.

OBJECTIVES: The objectives of the course are to teach students to

- Understand and estimate different competition indices.
- Understand different forms and approaches of forest models.
- Develop different types of forest growth and yield models and implement them.
- Develop volume, biomass and taper equations.
- Understand dendrochronology.

LEARNING OUTCOMES: After the completion of the course, students will be able to

- Develop volume, biomass and taper equation.
- Understand various forest models.
- Develop linear and non-linear growth model.
- Develop and use spatial and non-spatial competition indices.
- Collect and analyze dendrochronological data.

COURSE CONTENTS

UNIT 1: INTRODUCTION (4)

1.1 Introduction and Scope of Forest Biometrics
1.2 Application of Forest Biometrics (local, national and global level)
1.3 Individual Tree and Stand Level Parameter

UNIT 2: COMPETITION INDICES (4)

2.1 Two-sided Competition
  2.1.1 Distance Independent Competition
  2.1.2 Distance Dependent Competition
2.2 One-sided Competition
  2.2.1 Distance Independent Competition
  2.2.2 Distance Dependent Competition

UNIT 3: DATA SOURCE, DESIGN AND FORMS OF MODELS (10)

- 3.1 Introduction to Forest Models, Component, and Role
- 3.2 Data Sources for Forest Models (permanent sample plots, temporary sample plots, stump analysis, stem analysis, LiDAR, satellite imageries, Drone)
- 3.3 Construction of Growth Model
  - 3.3.1 Model Design
  - 3.3.2 Regression Techniques
  - 3.3.3 Statistical Assumptions
- 3.4 Different Forms of Models
  - 3.4.1 Linear and Non-Linear Modelling
  - 3.4.2 Binomial Data Modelling
  - 3.4.3 Generalized Additive Model (GAM)
  - 3.4.4 Generalized Linear Modelling (GLM)
  - 3.4.5 Mixed Effect Models
    - 3.4.5.1 Fixed Effect
    - 3.4.5.2 Random Effects

UNIT 4: GROWTH AND YIELD MODELLING APPROACHES AND EVALUATION (8)

- 4.1 Modelling Approaches
  - 4.1.1 Stand Table Projection
  - 4.1.2 Stand Level Model
  - 4.1.3 Individual Tree Model
    - 4.1.3.1 Distance Independent Model
    - 4.1.3.2 Distance Dependent Model
- 4.2 Evaluation of Forest Models
  - 4.2.1 Model Selection Criteria
  - 4.2.2 Model Validation
    - 4.2.2.1 Validation with Independent Data
    - 4.2.2.2 Validation with Split Data
    - 4.2.2.3 Cross Validation (leave one out, k-fold cross validation)
- 4.3 Volume, Biomass, and Taper Models (data requirement and model development)

UNIT 5: DENDRO-CHRONOLOGY (6)

- 5.1 Introduction and Origin of Dendro-Chronology
- 5.2 Principles of Dendro-Chronology
- 5.3 Data Requirement, Measurement and Analysis
- 5.4 Application of Dendro-Chronology

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit (s)
Review of different types of models	Literature review	Group presentation/report	Unit 2, 3
Data collection for volume, biomass and taper equation	Chain saw, hand saw, tape, caliper	Measurement of diameter, height, wood density (Groups wise)	Unit 3, 4
Exercise on tree level modelling	Computer, R software	Regression method	Unit 3
Exercise on mixed effect modelling	Computer, R software	Mixed modelling and regression	Unit 3
Exercise on volume, biomass, and taper equation	Computer, R software	Regression method	Unit 4
Tree core/disc collection and annual ring measurement	Increment borer	Visit nearby forest	Unit 5

KEY REFERENCES

Unit 1

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2. Prodan, M. (2014). Forest Biometrics. Pergamon. 460p.
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Unit 2

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Unit 4

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2. Van Laar, A., & Akça, A. (2007). *Forest mensuration* (Vol. 13). Springer Science & Business Media.
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4. Philip, M.S. (1983). Measuring Trees and Forests. Aberdeen University Press, University of Aberdeen, Aberdeen, UK.
5. Bhandari, S.K., Veneklaas, E.J., McCaw, L., Mazanec, R., Whitford, K., Renton, M. (2023). Investigating above- vs. below-ground competition by accounting for azimuth of competitors in native eucalypt forests. Forest Ecology and Management. 542, 121103. https://doi.org/10.1016/j.foreco.2023.121103.
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Unit 5

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2. Mishra, S.R. (2010). Textbook of dendrochronology. Discovery publishing house New Delhi. 185p.

SEMESTER III

COURSE TITLE: ADVANCED FOREST MANAGEMENT

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFM 601	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: Persistent impacts of global change on forest and associated policies, social and economic changes drive changes in forest management, and the nature of social demands on forests. In principle, management decisions highly depend on objective of forest management, interventions to maintain ecological integrity, and the costs and benefits of management interventions. Moreover, secured, future forest product markets, and greater flexibility in the policies and structures of forest management organizations may encourage forest owners to implement appropriate interventions. Forest managers need to consider trade-offs between different objectives under different conditions; yet require working in the future conditions subjected to a high degree of uncertainty. This requires forest management to be viewed through the lens of complex systems science.

OBJECTIVES: The objectives of this course are to:

- Enhance the understanding of basic principles planning and preparation of forest management plan and factors affecting forest management
- Understand the squarely needs of forest management and its major components,
- Understand yield regulation in uneven and even aged forest
- Develop a thorough understanding on the factors (e.g., market, global change) influencing forest management
- Understand the potentiality of developing forest management as an industry.

LEARNING OUTCOMES: Upon the completion of this course, the students will be able to:

- Set appropriate objectives and their better alternatives for the management of forest resources
- Understand key influencing factors affecting forest management and forest products, particularly both domestic and international markets and implacable policies, and global change
- Provide recommendations to policy makers to restructure forest management industry to optimize economic and ecological benefits of forest resources
- Provide recommendations and indicate opportunities to relevant authorities and entities to strengthen national forest monitoring system.

COURSE CONTENTS

UNIT 1. FOREST MANAGEMENT PLANNING (8)

1.1 Concept and Evolution of Forest Management Planning
1.2 Requirements for Forest Management Planning

1.3 Significance of Forest Management Planning
1.4 Level of Planning
    1.4.1 Strategic
    1.4.2 Tactical
    1.4.3 Operational
1.5 Component of Planning (technical and investment)
1.6 Timber Market and Trade Connected to Strategic Planning
1.7 Forestry Best Management Practices

UNIT 2: FOREST MANAGEMENT PLAN (8)

2.1 Preparation of Management Plans
    2.1.1 Setting Management Objectives
    2.1.2 Data Collection
        -Bio-physical
        -Socio-economical
    2.1.3 Silvicultural Plan
    2.1.4 Ecosystem Services and Biodiversity Management Plan
    2.1.5 Business Plan
    2.1.6 Risk and Uncertainty Management
    2.1.7 Monitoring and Evaluation

UNIT 3: YIELD REGULATION (8)

3.1 Revisit Yield Regulation
3.2 Regulating Plantation (even-aged) and Natural (uneven-aged) Forests
3.3 Allowable Cut Methods (area control, volume control, stem control, area and volume)
3.4 Yield Regulation Based on Site Quality/Productivity
3.5 Yield Regulation Practices in Nepal

UNIT 4: FACTORS INFLUENCING FOREST MANAGEMENT (4)

4.1 Forest Products (wood) Demand and Supply
4.2 Timber Production Potentials of Natural Forests
4.3 Societal Expectations
4.4 Timber Imports/Exports
4.5 Market Price and Harvesting Policy

UNIT 5: **FOREST MANAGEMENT: AS AN INDUSTRY (4)**

5.1 Forest Nursery
5.2 Reforestation
5.3 Tending Operations
5.4 Harvesting
5.5 Certification
5.6 Planning
5.7 Challenges in Developing Forest Management as an Industry in Nepal

PRACTICAL (16)

The learning objectives of the practical work/field work/excursion are,

- Assessment of forest management planning process at national, bilateral, and global levels, and critically review their impacts and implications,
- Practicing the yield regulation process through the use of inventory data and field visit.
- Developing skills for the preparation of forest management plan.

Contents	Equipment/tools	Methodology/methods	Link to Unit (s)
Review of forest management planning process	Literature	Group discussion and presentation	Unit 1, 2, 4
Yield regulation practice	Inventory data	Exercise	Unit 3
Preparation of forest management plan based on different objectives	Literature review/ management plans	Group work/field visit/report preparation	Unit 2, 4, 5

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1. Moreno, C.A. (2000). Forest Management Plan. Lee Town Forest, Lee, New Hampshire
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Unit 3

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Unit 4

1. Bont, L. G., Fraefel, M., Frutig, F., Holm, S., Ginzler, C., & Fischer, C. (2022). Improving forest management by implementing best suitable timber harvesting methods. *Journal of Environmental Management*, *302*, 114099.
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Unit 5

1. Haque, M. A., Miah, M. M., & Rashid, M. A. (2007). An economic study of plant nursery business in Gazipur and Jessore Districts of Bangladesh. *Bangladesh Journal of Agricultural Research*, *32*(3), 375-385.
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COURSE TITLE: FOREST GROWTH AND SILVICULTURE

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFB 602	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: The course aims to provide a comprehensive understanding of forest growth and silviculture, encompassing various aspects of tree growth, stand dynamics, and silvicultural practices. Students will delve into the anatomical and physiological dimensions of tree growth, analyze stand dynamics in even-aged and uneven-aged stands, and explore silviculture's role in shaping tree growth. Additionally, the course will cover the dynamics of forest gap and group openings and various silviculture practices to enhance tree growth and quality. Through a combination of classroom lectures, group discussions and practical exercises, students will acquire the knowledge and skills needed to address emerging issues in the field of forest growth and silviculture.

OBJECTIVES: The objectives of the course are to:

- Understand individual tree and stand growth fundamentals
- Understand the growth dynamics of even-aged and uneven-aged stands
- Gain insights into the dynamics of forest gap and group openings
- Understand the impact of thinning on tree- and stand-level responses
- Plan and implement silvicultural strategies to achieve diverse objectives

LEARNING OUTCOMES: Upon completion of this course, the students will be able to:

- Explain anatomical and physiological aspects of tree growth
- Assess stand dynamics in both even-aged and uneven-aged stands
- Evaluate the dynamics of forest gap and group openings
- Plan and implement silviculture practices to improve tree growth, quality and stand productivity
- Evaluate thinning impact on tree and stand-level responses, and analyze their effect on the economic yield of a stand
- Apply diverse silviculture strategies for various objectives

UNIT 1: GROWTH OF TREES (6)

1.1 Types of Tree Growth
  1.1.1 Anatomical Growth
  1.1.2 Physiological Growth
1.2 Growth of Trees
  1.2.1 Pure Stands and Mixed Stands
  1.2.2 Even Aged and Uneven Aged Stands
1.3 Role of Silviculture in Tree Growth

UNIT 2: STAND GROWTH (8)

2.1 Dynamics of Even Aged Stands
- 2.1.1 Langsaeter's Hypothesis/Curve
- 2.1.2 Age-Growth Relationship (age-related changes in stand productivity: changes in photosynthesis, growth Law, nutrient supply, respiration, allocation, structure and function)
- 2.1.3 Size-Growth Relationship (interaction of tree dominance and stand production)

2.2 Dynamics of Uneven-Aged Stands
- 2.2.1 Dynamics of Light-Limited Systems
- 2.2.2 Dynamics of Moisture-Limited Systems
- 2.2.3 Tree and Stand Architecture
- 2.2.4 Growth Patterns
- 2.2.5 Mortality

UNIT 3: DYNAMICS OF FOREST GAP AND GROUP OPENINGS (4)

3.1 Gap Dynamics
3.2 Gap Variability
3.3 Implications of Gap Variability for Regeneration and Growth

UNIT 4: SILVICULTURE PRACTICES IMPROVING TREE GROWTH AND QUALITY (4)

4.1 Natural Forests (selection of improved tree stocks, assisted natural regeneration, managing competition, altering stand density)
4.2 Plantation Forests (selection of improved tree stocks, fertilization, moisture management, managing competition, altering stand density)

UNIT 5: THINNING AND GROWTH (6)

5.1 Thinning Decisions – Why and Which?
5.2 Tree-Level Responses to Thinning
5.3 Stand-Level Responses to Thinning
5.4 Effect of Thinning on Economic Yield of Stand

UNIT 6: SILVICULTURE FOR DIVERSE OBJECTIVES (4)

6.1 Timber – Quantity and Quality
6.2 Wildlife Habitat
6.3 Forest Carbon
6.4 Forest Restoration
6.5 Landslide/ Soil Erosion

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Stem Growth	Permanent slide / Temporary slide / Microscope	Lab / Section cutting	Unit 1
Stand Growth (Even- and Uneven-aged)	Permanent / Temporary Slide/ Microscope	Lab, Section Cutting	Unit 2
Gaps and regeneration	Observation	Field visit and report	Unit 3, 4, and 5
Response to Thinning	Equipment	Field / Measurement/ Ring count	Unit 5

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Unit 1

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Unit 2

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Unit 3

1. O'Hara, K. L. (2014). *Multiaged Silviculture: Managing for Complex Forest Stand Structures*. Oxford University Press, Oxford, UK.

Unit 4

1. Ashton, M. S., & Kelty, M. J. (2018). *The Practice of Silviculture: Applied Forest Ecology* (10th Ed.). John Wiley & Sons

Unit 6

1. O'Hara, K. L. (2014). *Multiaged Silviculture: Managing for Complex Forest Stand Structures*. Oxford University Press, Oxford, UK.

COURSE TITLE: FOREST PRODUCTS AND WOOD ENGINEERING

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
FPE 603	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: This course has a broad scope, focusing on knowledge development and its application to business growth at both local and national levels. It emphasizes the wood properties to enhance finished product quality. Topic covered include wood-based manufacturing processes, wood preservatives, durability measures, value addition strategies, and the integration of circular economy principles in the wood industries. The course is designed to equip students with the essential skills needed to understand wood properties for utilization in both national and international markets. Overall, it offers a comprehensive education that combines theoretical understanding with practical applications, fostering a holistic approach to forest products and wood engineering.

OBJECTIVES: The objectives of this course are to:

- Understand the Forest product used as a resource
- Describe various types of wood structure and functions
- Describe wood properties and its strength
- Understand the prolonging techniques of the life (shelf-life) of wood through seasoning and application of preservatives-based treatment
- Evaluate value addition about round and engineered wood products

LEARNING OUTCOMES: By the end of the study, students are expected to be able to:

- Demonstrate a clear understanding of various forest products and their utilization to its end use application.
- Able to understand the orthotropic nature and factors affecting wood strength
- Apply the knowledge of wood and moisture relations.
- Demonstrate understanding of wood seasoning and preservation
- Evaluate the uses of both round timber and engineered wood products

UNIT 1: FOREST PRODUCTS AS A RESOURCE (4)

1.1 Concept of forest products
1.2 Types of Forest Products (Timber and Non timber products)
1.3 Classification of Forest Products (food products, wood and timber products and other forest products)
1.4 Wood as a Sustainable Building Material

UNIT 2: STRUCTURE AND FUNCTION OF WOOD (5)

2.1 Biological Structure of Wood at Decreasing Scales
2.1.1 Softwood and Hardwood (Species)
2.1.2 Sapwood and Heartwood (Tree)
2.1.3 Axial and Radial Systems (Log)

2.1.4 Planes of Section (Lumber)

2.2 Wood Structure in Relation to End Use of Wood

UNIT 3: WOOD PROPERTIES (9)

3.1 Physical

3.2 Chemical

3.3 Mechanical

3.3.1 Orthotropic Nature of Wood

3.3.2 Elastic Properties

3.3.3 Strength Properties

3.3.3.1 Common Properties

3.3.3.2 Modulus of Rupture

3.3.3.3 Work to Maximum Load in Bending

3.3.3.4 Compressive Strength Parallel to Grain

3.3.3.5 Shear Strength Parallel to Grain

3.3.3.6 Impact Bending

3.3.3.7 Tensile Strength Perpendicular to Grain

3.3.3.8 Hardness

3.3.3.9 Tensile Strength Parallel to Grain

3.3.4 Factors Affecting Wood Strength

UNIT 4: WOOD TREATMENT (6)

4.1 Wood and Moisture Relation

4.2 Wood Seasoning

4.2.1 Concept

4.2.2 Importance and Scope

4.3 Wood preservation

4.3.1 Concept

4.3.2 Importance and Scope

4.3.3 Effects on the Environment

4.3.4 Recycling and Disposal of Treated Wood

UNIT 5: VALUE ADDITION OF WOOD (8)

5.1 Round Timber

5.1.1 Standard Requirement

5.1.2 Material Requirement

5.1.3 Availability (pole, plies, and construction logs)

5.1.4 Uses of Round Wood Timber

5.2 Engineered Wood Products

5.2.1 Raw Material

5.2.2 Engineered Wood Products

5.2.3 Uses of Engineered Wood Products

5.2.4 Engineered Wood as a Circular Economy / Bio–Economy

5.2.5 Mechanical Performance of Engineered Wood Products

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Wood Identification	Hand lens	Lab test	Unit 2
Properties of wood	Hand lens	Lab test	Unit 3
Mechanical testing	UTM	Lab test	Unit 3
Wood treatment	Case study	(Factory Visit-Excursion)	Unit 4
Value addition of wood	Case study	(Factory Visit-Excursion)	Unit 5

KEY REFERENCES

Unit 1

1. Forest Products Laboratory (US). (1987). *Wood handbook: wood as an engineering material* (No. 72). The Laboratory.
2. FRI (1970). Indian Forest Utilization, Vol. I, Forest Research Institute, Dehradun.
3. Mehta, T. (2008). *Handbook of Forest Utilization*. International Book Distributors.

Unit 2

1. Forest Products Laboratory (US). (1987). *Wood handbook: wood as an engineering material* (No. 72). The Laboratory
2. FRI (1970). Indian Forest Utilization, Vol. I, Forest Research Institute, Dehradun.
3. Jeffery, E.C. (1917). The Anatomy of Wood Plants. University of Chicago Press, Chicago.

Unit 3

1. FRI (1970). Indian Forest Utilization, Vol. I, Forest Research Institute, Dehradun.
2. Forest Products Laboratory (US). (1987). *Wood handbook: wood as an engineering material* (No. 72). The Laboratory
3. Mehta, T. (2008). *Handbook of Forest Utilization*. International Book Distributors.

Unit 4

1. FRI (1970). Indian Forest Utilization, Vol. I, Forest Research Institute, Dehradun.
2. Forest Products Laboratory (US). (1987). *Wood handbook: wood as an engineering material* (No. 72). The Laboratory
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Unit 5

1. FRI (1970). Indian Forest Utilization, Vol. I and II, Forest Research Institute, Dehradun.
2. Forest Products Laboratory (US). (1987). *Wood handbook: wood as an engineering material* (No. 72). The Laboratory
3. Mehta, T. (2008). *Handbook of Forest Utilization*. International Book Distributors.

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1. Verkerk, P. J., Hassegawa, M., Van Brusselen, J., Cramm, M., Chen, X., Imparato Maximo, Y., & Koç, M. (2021). *Forest products in the global bioeconomy: Enabling substitution by wood-based products and contributing to the Sustainable Development Goals*. Food & Agriculture Org.
2. Carus, M., & Dammer, L. (2018). The circular bio economy—concepts, opportunities, and limitations. *Industrial biotechnology*, *14*(2), 83-91.
3. Tsoumis, G. (2013). *Wood as raw material: source, structure, chemical composition, growth, degradation and identification*. Elsevier.

COURSE TITLE: FOREST ECOLOGY AND ECOSYSTEM MANAGEMENT

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFB 604	3	48 (32+16)	75 (45+30)

Note: 1 credit = 16 lecture hours

SCOPE: This course introduces the concepts of forest ecology and ecosystem management and discusses how different ecological principles and approaches can be used for sustainable management and/or restoration of forest ecosystems. The course combines classroom lectures with practical exercises to provide students with the necessary knowledge and skills to address emerging issues in the field of forest ecology and ecosystem management.

OBJECTIVES: The objectives of this course are to:

- Understand the concept of the forest ecosystem and its dynamics
- Learn ecosystem processes, functions, and services
- Understand forests as social-ecological system
- Learn the concept and principles of the ecosystem approach and its application
- Learn the concept of ecosystem modelling and its application

LEARNING OUTCOMES: Upon completion of this course, the students will be able to

- Appraise the effects of various disturbances on forest stand development & succession
- Document ecosystem processes, functions, and services
- Manage forests as social-ecological system
- Apply the concept and principles of the ecosystem approach
- Apply ecosystem modelling as a decision support tool

COURSE CONTENTS

UNIT 1: UNDERSTANDING FORESTS AS ECOSYSTEM (5)

1.1 Concept of Forest Ecosystem (What makes forest an ecosystem?)
1.2 Forest Ecosystem Dynamics (Quick revisit/recap)
  1.2.1 Disturbances: Concept, Classification, and Disturbance Regime (Gap dynamics)
  1.2.2 Conceptual Stages of Stand Development
  1.2.3 Successional Trajectories

UNIT 2: FOREST ECOSYSTEM PROCESSES, FUNCTIONS AND SERVICES (8)

2.1 Forest Ecosystem Processes
  2.1.1 Productivity
  2.1.2 Energy flow
  2.1.3 Nutrient Cycling
  2.1.4 Water Cycling
2.2 Forest Ecosystem Function
  2.2.1 Production Function
  2.2.2 Regulation Function

2.2.3 Support Function
2.2.4 Information Function

2.3 Forest Ecosystem Services
2.3.1 Provisioning Services
2.3.2 Regulating Services
2.3.3 Supporting Services
2.3.4 Cultural Services

UNIT 3: UNDERSTANDING FORESTS AS SOCIAL-ECOLOGICAL SYSTEM (6)

3.1 Concept of Social-Ecological System
3.2 Journey from Forests as Self-sustaining Ecosystems to Social-Ecological Systems
3.3 Factors/Processes that Shape Forests as Social-Ecological Systems
3.4 Implications for Management

UNIT 4: ECOSYSTEM APPROACH (6)

4.1 Concept and Principles of Ecosystem Approach
4.2 Single-Species or Stand Management to Ecosystem Management - A Paradigm Shift from
4.3 Variations of Ecosystem Approach
4.3.1 Ecosystem Based Management
4.3.2 Ecosystem Management
4.3.3 Ecosystem Based Adaptation
4.4 Steps to Implementation

UNIT 5: ECOSYSTEM MODELING (7)

5.1 Ecosystem Modeling Concept
5.2 Types of Ecosystem Models
5.3 Applications of Ecosystem Models
5.3.1 Describe and Understand Ecosystem Status/Condition
5.3.2 Make Predictions about Future and Past Ecosystem States
5.3.3 Inform Decision-Making by Comparing Alternative Strategies and Identifying Important Uncertainties
5.4 Steps of Ecosystem Modeling
5.4.1 Conceptual Model Formulation
5.4.2 Quantitative Model Specification
5.4.3 Model Evaluation
5.4.4 Model Use
5.4.5 Sensitivity Analysis

PRACTICAL (16)

Contents	Equipment/tools	Methodology/ methods	Link to Unit(s)
Visit nearby forests for observing and understanding the effects of disturbances on forest stand development & succession		Site visit	Unit 1
Document ecosystem processes, functions, and services of nearby managed and unmanaged forests		Site visit	Unit 2
Review literature on implications of social-ecological system for management	Literature	Literature review	Unit 3
Building and running a simple ecosystem model (e.g., Simile, Vensim, Ecopath with Ecosim, En-ROADS from Climate Interactive, PhET Interactive Simulations, NetLogo, etc.)	Software and tutorials	Classroom exercise	Unit 4, 5

KEY REFERENCES

Unit 1

1. Chazdon, R. L. (2014). Tropical forest dynamics and disturbance regimes. In Second growth: The promise of Tropical Forest regeneration in an age of deforestation (pp. 55–72). University of Chicago Press. https://doi.org/10.7208/chicago/9780226118109.003.0004 **(Unit 1)**
2. Oliver, C. D., & Larson, B. C. (1996). Forest stand dynamics (Update). EliScholar, Yale University Library. **(Unit 1)**

Unit 2

1. de Groot, R. S., Wilson, M. A., & Boumans, R. M. J. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics, 41, 393–408. www.elsevier.com/locate/ecolecon **(Unit 2)**
2. Millennium Ecosystem Assessment. (2003). Ecosystems and their services. In Ecosystems and human well-being: A framework for assessment (pp. 49–70). **(Unit 2)**

Unit 3

1. Fischer, A. P. (2018). Forest landscapes as social-ecological systems and implications for management. Landscape and Urban Planning, 177, 138–147. https://doi.org/10.1016/j.landurbplan.2018.05.001 **(Unit 3)**
2. Vogt, J. (2020). Urban forests as social-ecological systems. In Encyclopedia of the World's Biomes (Vols. 5–5, pp. 58–70). Elsevier. https://doi.org/10.1016/B978-0-12-409548-9.12405-4 **(Unit 3)**

Unit 4

1. Convention on Biological Diversity. (2023). Ecosystem Approach. Https://Www.Cbd.Int/Ecosystem/. https://www.cbd.int/ecosystem/ **(Unit 4)**
2. Waltner-Toews, D., Kay, J. J., & Lister, N. M. E. (Eds.). (2008). *The ecosystem approach: Complexity, uncertainty, and managing for sustainability*. Columbia University Press. **(Unit 4)**
3. Shepherd, G. (2004). The ecosystem approach: Five steps to implementation. **(Unit 4)**

Unit 5

1. Geary, W. L., Bode, M., Doherty, T. S., Fulton, E. A., Nimmo, D. G., Tulloch, A. I. T., Tulloch, V. J. D., & Ritchie, E. G. (2020). A guide to ecosystem models and their environmental applications. In Nature Ecology and Evolution (Vol. 4, Issue 11, pp. 1459–1471). Nature Research. https://doi.org/10.1038/s41559-020-01298-8 **(Unit 5)**
2. Jørgensen, S. E., & Fath, B. D. (2011). Fundamentals of ecological modelling: Applications in environmental management and research (Fourth). Elsevier. **(Unit 5)**

COURSE TITLE: FOREST ECOSYSTEM HEALTH (OPTIONAL)

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFB 605	3	48 (32+16)	75 (45+30)

Note: 1 credit = 16 lecture hours

SCOPE: This course introduces the concepts of forest ecosystem health and its indicators and environmental stressors, discusses how different environmental stressors may negatively affect the health and sustainability of forest ecosystems, and discusses when and what management actions should be undertaken to avoid, manage or mitigate environmental stressors to protect or improve forest ecosystem health and sustainability. The course combines classroom lectures with practical exercises to provide students with the necessary knowledge and skills to address emerging threats to forest ecosystem health and sustainability.

OBJECTIVES: The objectives of this course are to:

- Understand the concept of forest ecosystem health and its indicators
- Understand the concept of environmental stressors
- Learn the process of ecosystem health assessment
- Familiarize with the techniques of ecosystem health assessment
- Learn approaches to plan & implement management actions to avoid, manage, or mitigate environmental stressors to protect or improve forest ecosystem health and sustainability

LEARNING OUTCOMES: Upon completion of this course, the students will be able to

- Develop indicators for ecosystem health assessment
- Identify the probable environmental stressors
- Assess potential negative effects of different environmental stressors on forest ecosystem health and sustainability
- Plan & implement management actions to avoid, manage or mitigate environmental stressors to protect or improve forest ecosystem health and sustainability

COURSE CONTENTS

UNIT 1 FOREST ECOSYSTEM HEALTH AND ITS INDICTORS (6)

1.1 Concept of Forest Ecosystem Health
1.2 Indicators of Forest Ecosystem Health (e.g., USDA, Forest Service Forest Ecosystem Health Indicators)
  1.2.1 Crown Condition
  1.2.2 Tree Damage
  1.2.3 Tree Mortality and Standing Dead Trees
  1.2.4 Lichen Communities
  1.2.5 Down Woody Materials
  1.2.6 Vegetation Profile
  1.2.7 Soil Quality
  1.2.8 Invasive Alien Plants

1.2.9 Regeneration and Browse Impact
1.2.10 Fragmentation and Landscape Context

UNIT 2 ENVIRONMENTAL STRESSORS (8)

2.1 Biotic Stressors
- 2.1.1 Insects
- 2.1.2 Pathogens
- 2.1.3 Parasites
- 2.1.4 Herbivores
- 2.1.5 Invasive Alien Species
- 2.1.6 Lack of Management & Mismanagement
- 2.1.7 Encroachment

2.2 Abiotic Stressors
- 2.2.1 Climate Change
- 2.2.2 Fire
- 2.2.3 Drought
- 2.2.4 Pollution

UNIT 3 FOREST ECOSYSTEM HEALTH ASSESSMENT (5)

3.1 Significance of Forest Ecosystem Health Assessment

3.2 Process of Forest Ecosystem Health Assessment
- 3.2.1 Define target entity
- 3.2.2 Identify Objective(s) and Assessment Questions(s)
- 3.2.3 Define Spatial and/or Ecological Coverage
- 3.2.4 Identify Indicators and Indices to be Used
- 3.2.5 Define Intensity Level of Monitoring
- 3.2.6 Select Appropriate Sampling Strategy and Tactic
- 3.2.7 Define Time Span
- 3.2.8 Incorporate Rigorous Quality Assurance Procedures
- 3.2.9 Select Appropriate Evaluation Method
- 3.2.10 Report the Results

UNIT 4 FOREST ECOSYSTEM HEALTH ASSESSMENT AND MONITORING TECHNIQUES (8)

4.1 Forest Ecosystem Health Assessment and Monitoring Using In-Situ Forest Inventory Data

4.2 Forest Ecosystem Health Assessment and Monitoring Using Remote Sensing Data

4.3 Forest Ecosystem Health Assessment and Monitoring Using Simulation Models (e.g., USDA, Forest Service Forest Vegetation Simulator Models)

UNIT 5 MANAGEMENT FOR FOREST ECOSYSTEM HEALTH (5)

5.1 Forest Ecosystem Health as a Management Goal

5.2 Good Practices for Protecting the Health of Forest Ecosystems
- 5.2.1 Preventative Measures
- 5.2.2 Early Detection and Rapid Response
- 5.2.3 Integrated Pest Management for Forestry

5.2.4 Forest Restoration
5.2.5 Active Forest Management
5.2.6 Collaboration

5.3 Forest Ecosystem Health and Forest Ecosystem Management

PRACTICAL (16)

Contents	**Methodology/methods**	**Link to Unit(s)**
Visit nearby forests for observing and understanding environmental stressors	Site visit	Unit 2
Prepare a brief plan for the assessment of forest ecosystem health	Group work	Unit 1, 2, 3
Review of forest ecosystem health assessment techniques	Literature review	Unit 4
Document outcomes of good practices of protecting forest ecosystem health	Group work and presentation	Unit 5

KEY REFERENCES

Unit 1

1. Jørgensen, S. E., Xu, F. L., & Costanza, R. (2010). Handbook of ecological indicators for assessment of ecosystem health. CRC Press, Taylor & Francis Group. **(Unit 1)**
2. Kolb, T. E., Wagner, M. R., & Covington, W. W. (1994). Concepts of forest health: utilitarian and ecosystem perspectives. Journal of Forestry, 92(7), 10–15. https://doi.org/https://doi.org/10.1093/jof/92.7.10 **(Unit 1)**
3. Randolph, K. C., Morin, R. S., Dooley, K., Nelson, M. D., Jovan, S., Woodall, C. W., Schulz, B. K., Perry, C. H., Kurtz, C. M., Oswalt, S. N., McWilliams, W. H., & Riemann, R. (2020). Forest ecosystem health indicators. https://usfs.maps.arcgis.com/apps/MapJournal/index.html?appid=a434a8d7b3d447c8a747efb4fd22d742# **(Unit 1)**

Unit 2

1. Teshome, D. T., Zharare, G. E., & Naidoo, S. (2020). The threat of the combined effect of biotic and abiotic stress factors in forestry under a changing climate. In Frontiers in Plant Science (Vol. 11). Frontiers Media S.A. https://doi.org/10.3389/fpls.2020.601009 **(Unit 2)**

Unit 3

1. Ferretti, M. (1997). Forest health assessment and monitoring - Issues for consideration. Environmental Monitoring and Assessment, 48, 45–72. **(Unit 3)**

Unit 4

1. Lausch, A., Erasmi, S., King, D. J., Magdon, P., & Heurich, M. (2016). Understanding forest health with remote sensing-Part I-A review of spectral traits, processes and remote-sensing characteristics. In Remote Sensing (Vol. 8, Issue 12). MDPI AG. https://doi.org/10.3390/rs8121029 **(Unit 4)**
2. Lausch, A., Erasmi, S., King, D. J., Magdon, P., & Heurich, M. (2017). Understanding forest health with Remote sensing-Part II-A review of approaches and data models. In Remote Sensing (Vol. 9, Issue 2). MDPI AG. https://doi.org/10.3390/rs9020129 (Unit 4)
3. Meng, Y., Cao, B., Dong, C., & Dong, X. (2019). Mount Taishan Forest ecosystem health assessment based on forest inventory data. Forests, 10(8). https://doi.org/10.3390/f10080657 **(Unit 4)**

Unit 5

1. Steedman, R. J. (1994). Ecosystem Health as a Management Goal. In Source: Journal of the North American Benthological Society (Vol. 13, Issue 4). **(Unit 5)**
2. Wang, D., Yang, X., Xing, W., Liu, C., & Chang, H. (2020). Ecosystem health and forest ecosystem management. IOP Conference Series: Earth and Environmental Science 598 (2020) 012028, 598(1). https://doi.org/10.1088/1755-1315/598/1/012028 **(Unit 5)**

COURSE TITLE: NATURAL RESOURCE PROFESSIONAL ETHICS (OPTIONAL)

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
SFM 606	3	48 (32+16)	75 (45+30)

Note: 1 Credit= 16 Lecture Hours

SCOPE: This course focuses on the ethical aspects of the delivery of professional services in the field of natural resource management. It emphasizes the importance of conducting one's work in a just, fair, and ethically responsible manner, especially when balancing the demands of resource conservation and the fulfillment of legitimate human needs. The course offers valuable guidance on how to navigate these complex ethical dilemmas and make decisions that align with a strong moral and environmental compass. Students will gain the knowledge and skills necessary to address these issues in a professional and responsible manner, ensuring sustainable management of natural resources for the benefit of current and future generations.

OBJECTIVES: Upon completion of the course, students will have acquired a deep understanding of professional ethics in natural resource management and developed the ability to apply ethical principles to real-world challenges in this field, leading to responsible and sustainable resource management practices. The specific objectives are:

- Students will demonstrate a comprehensive knowledge of historical and contemporary ethical frameworks in the management of natural resources, allowing them to recognize ethical dilemmas and principles in this context.
- Students will develop problem-solving skills to address practical ethical challenges through case analysis, discussions, and group work within a professional setting.
- Students will cultivate a personal commitment to ethical conduct and develop a code of professional behavior consistent with the principles of professional ethics in the management of natural resources.

LEARNING OUTCOMES

- **Ethical competence:** Graduates will have a strong ethical foundation and deep understanding of professional ethics in natural resource management, enabling them to navigate complex ethical challenges in their careers.
- **Problem-solving:** Graduates will demonstrate the ability to effectively address practical ethical dilemmas within the field of natural resource management, employing analytical skills and critical thinking to develop sound ethical solutions.
- **Personal ethical commitment:** Graduates will cultivate a personal code of professional conduct consistent with the principles of professional ethics in natural resource management, reflecting a commitment to ethical behavior in their careers.

COURSE CONTENTS

UNIT 1: INTRODUCTION (4)

1.1 Define Ethics, Areas of Ethics (meta, normative, and applied), Norms and Values.

1.2 Applied Ethics Approaches (utilitarianism, deontological, virtue) and Major Subfields.
1.3 Profession, Professionalism, Professional Ethics, and Professional Practice.
1.4 Developing Professional Ethical Reflections on Natural Resource Management.

UNIT 2: NATURE AND ETHICS (8)

2.1 Rights of Trees and Nature, Animal Rights and Welfare.
2.2 Definition, Types, Principles and Importance of Environmental Ethics in Nature Conservation and Protection.
2.3 Anthropocentrism vs. Ecocentrism Views on Nature.
2.4 Environmental Justice: Concept of Justice and Fairness, Distributional Inequality and Environmental Injustice, Interlinkage Between Environmental Ethics, Social Justice and Sustainable Resource Management.

UNIT 3: PROFESSIONAL ETHICS (8)

3.1 Loyalty to Employer, Responsibility and Duty, Confidentiality and Proprietary Information, Occupational Safety and Ethics, Digital and Cyber Ethics Including the Use of Robotics and Artificial Intelligence (AI)
3.2 Public Duties: Moral Obligations of Government Servants, NGOs, INGOs and Other Public Institutions, Professional Consulting and Advertising
3.3 Conflicts of Interest in Decision Making: Recognizing and Resolving Conflicts of Interest in Professional Judgments in Natural Resources Management
3.4 Program Operation and Activities: Institutional Ethical Board/Committee, Code of Conduct, Program Activity Plans and Inclusiveness, Prior Informed Consent, Request for Permission

UNIT 4: ETHICAL DECISION-MAKING METHODS AND TOOLS (6)

4.1 Methods: Situation Analysis, Moral Reasoning, Practical Reasoning, Precautionary Principle
4.2 Tools: Ethics Codes and Professional Standards; Compliance with Laws, Regulations and Standards; Code of Conduct; and Ethical Checklists
4.3 Audits: Social Audit, Social Media Audit

UNIT 5: ETHICAL ISSUES AND DILEMMAS (6)

5.1 Ethical Issues: Corruption, Lack of Transparency, Prioritizing Private Interests Over Public Good, and Influence of Special Interests and Politics on Policies
5.2 Ethical Dilemmas: Balance Economic Interests with Conservation, Managing Competing Demands on Land Resources, Weighing Single vs. Multiple Values in Forests, and Conflicts between Short-term and Long-term Goals

PRACTICAL (16)

At least two practical tasks (1 individual and 1 group work) must be performed, and the instructor of the course should organize a workshop in which students present their individual assignments.

- **Ethical reflection paper (Individual):** This assignment encourages students to engage in individual ethical reflection on a specific interest, aligning their personal ethical values with the course's ethical principles.
- **Role-play scenario (Group):** Through this group assignment, students will investigate ethical dilemmas within various environmental philosophies, allowing them to apply ethical principles in a practical context.
- **Conflict resolution (Individual):** By providing students with a real case of conflict of interest in resource management, this assignment assesses their ability to recognize and manage conflicts of interest in a professional context.
- **Situation analysis (Group):** Student groups engage in situation analysis by examining real-world case studies with ethical dilemmas. This promotes their practical skills in ethical decision-making.
- **Professional ethics workshop (Individual/Group):** Student groups organize and conduct a workshop on professional ethics in natural resource management, providing an opportunity for them to demonstrate and share their understanding of the course's ethical principles and their practical application by presenting their ethical reflection paper.

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Ethical reflection paper (individual)	A case for a student	Review of the literature	Unit 1, 2, 3, 4, 5
Role-play scenario (group)	Ethical dilemmas and environmental philosophy	Assign student groups a role-play scenario on an ethical dilemma using environmental philosophy.	Unit 2
Conflict resolution (individual)	Cases of conflict of interest, one per student	Provide real cases of conflict of interest in resource management and guide students in solving it.	Unit 3
Situation Analysis (Group)	Ethical dilemmas in decision-making in resource conservation	Provide student groups with real-world case studies that involve ethical dilemmas in decision-making.	Unit 4
Professional ethics workshop	Space for workshops, audiovisual aids	The teacher/students organize an in-house presentation workshop on professional ethics in natural resource management, and students present their individual assignment.	Unit 1, 2, 3, 4, 5

KEY REFERENCES

Unit 1

1. Irland. L.C. (2007). Professional Ethics for Natural Resource and Environmental Managers: A Primer. Yale School of Forestry & Environmental Studies, Forestry & Environmental Studies Publications Series. 7. [Chapter 1, 2]
2. Jamieson, D. (2008). Ethics and the environment: an introduction. Cambridge University Press. United Kingdom. www.cambridge.org/9780521864213. [Chapter 1]

3. Kelly, T.M. (2018). Professional ethics: a trust-based approach. Lexington Books, London. [Chapter 1]
4. T. Airaksinen. (2012). Professional Ethics: Ruth Chadwick, Encyclopedia of Applied Ethics (Second Edition), Academic Press, Pages 616-623. ISBN 9780123739322. https://doi.org/10.1016/B978-0-12-373932-2.00080-6.

Unit 2

1. Jamieson, D. (2008). Ethics and the environment: an introduction. Cambridge University Press. United Kingdom. www.cambridge.org/9780521864213 [Chapter 1, 6]
2. Lee, W. N. (2022). This is environmental ethics: an introduction. John Wiley and Sons Ltd. United Kingdom. [Chapter 1, 6]
3. Mohai, P., Pellow, D. & Roberts, J.T. (2009). Environmental justice. *Annual Review of Environment and Resources*, *34*, pp.405-430. https://doi.org/10.1146/annurev-environ-082508-094348
4. Hale, B., Light, A., & Lawhon L. A. (2023). The Routledge Companion to Environmental Ethics. Taylor and Francis, New York and London. [Chapter 1, 5, 63]

Unit 3

1. Irland. L.C. (2007). Professional Ethics for Natural Resource and Environmental Managers: A Primer. Yale School of Forestry & Environmental Studies, Forestry & Environmental Studies Publications Series. 7 [Chapter 6 to 10]
2. Kelly, T.M. (2018). Professional ethics: a trust-based approach. Lexington Books, London. [Chapter 3, 6]
3. Meyers, C. (2018). The professional ethics toolkit. John Wiley and Sons Ltd. United Kingdom. [Chapter 6-8]
4. T. Airaksinen. (2012). Professional Ethics: Ruth Chadwick, Encyclopedia of Applied Ethics (Second Edition), Academic Press, Pages 616-623. ISBN 9780123739322

Unit 4

1. Meyers, C. (2018). The professional ethics toolkit. John Wiley and Sons Ltd. United Kingdom. [Chapter 2, 9]
2. Lee, W. N. (2022). This is environmental ethics: an introduction. John Wiley and Sons Ltd. United Kingdom. [Chapter 1]
3. Hale, B., Light, A., & Lawhon L. A. (2023). The Routledge Companion to Environmental Ethics. Taylor and Francis, New York and London. [Chapter 58]

Unit 5

1. Jamieson, D. (2008). Ethics and the environment: an introduction. Cambridge University Press. United Kingdom. www.cambridge.org/9780521864213 [Chapter 6]
2. Meyers, C. (2018). The professional ethics toolkit. John Wiley and Sons Ltd. United Kingdom. [Chapter 9]
3. Hale, B., Light, A., & Lawhon L. A. (2023). The Routledge Companion to Environmental Ethics. Taylor and Francis, New York and London. [Chapter 54-56]

SEMESTER IV

Proposal
Pre-defense
Dissertation
Manuscript of Research Work