

TRIBHUVAN UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY



COURSE STRUCTURE & CURRICULUM

M.Sc. (MOUNTAIN & MOUNTAINEERING SCIENCE)

OR

M.Sc. (MMS)

FEBRUARY 2023

COURSE STRUCTURE SEMESTERS WISE COURSES

First Semester's Courses		
Course code	Course title	Credits
MMS501	Mountain Tourism & Mountaineering: Concept & Practices	3
MMS502	Mountaineering in Nepal	3
MMS503	Mountain Geography	3
MMS504	Mountain Climate & Hydrology	3
MMS505	Research Methodology	2
MMS506	Geographic Information System & Remote Sensing	2
MMS531	Practical Work - I	2
MMS532	Practical Work - II	2
Total paper (8)	Total credits	20
Second Semester's Courses		
MMS551	Mountain Safety Protocols	3
MMS552	Environmental Impact of Mountain Tourism	3
MMS553	Glacial Geomorphology	3
MMS554	Dynamics of Snow, Ice & Glacier	3
MMS555	Mountain Ecology & Bio-diversity	3
MMS556	Statistical Methods	2
MMS581	Practical Work - III	2
MMS591	Mountain Tourism Development: Policies & Plans	Elective
MMS592	Mountain People & Livelihood	
MMS593	International Cooperation, Diplomacy & Mountains	
Total paper (8)	Total credits	21
Third Semester's Courses		
MMS631	Field Work - I (Research)	2
MMS632	Field Work - II (Research)	4
MMS633	Case Study: Mountain Safety Protocols (Research)	1
MMS634	Case Study: Environmental Impact of Mountain Tourism (Research)	1
MMS649	Dissertation Proposal Seminar (Research)	1
Total Paper (5)	Total credits	9
Forth Semester's Courses		
MMS697	Dissertation Defense (Research)	2
MMS698	Publication of Scientific Article (Research)	3
MMS699	Dissertation (Research)	9
Total Paper (3)	Total credits	14
GRAND TOTAL PAPERS (24)	GRAND TOTAL CREDITS	64

Theoretical of courses

Theory (Compulsory) Courses		
Code	Course Title	Credits
MMS501	Mountain Tourism & Mountaineering: Concept & Practices	3
MMS502	Mountaineering in Nepal	3
MMS503	Mountain Geography	3
MMS504	Mountain Climate & Hydrology	3

MMS505	Research Methodology	2
MMS506	Geographic Information System & Remote Sensing	2
MMS556	Statistical Methods	2

Total theory (compulsory) course credits (A) 18

Theory (Specialized) Courses		
Code	Course Title	Credits
MMS551	Mountain Safety Protocols	3
MMS552	Environmental Impact of Mountain Tourism	3
MMS553	Glacial Geomorphology	3
MMS554	Dynamics of Snow, Ice & Glacier	3
MMS555	Mountain Ecology & Bio-diversity	3

Total theory (specialized) course credits (B) 15

Elective Courses (any one paper will be offered out of these courses)		
Code	Course Title	Credits
MMS591	Mountain Tourism Development: Policies & Plans	2
MMS592	Mountain People & Livelihood	2
MMS593	International Cooperation, Diplomacy & Mountains	2

Total elective course credits (C) 2

Total credits of theory course-D (A+ B +C) 35

Practical/ Research of courses/works

Practical (Indoors and Field) Courses			
Code	Course Title	Course Covered	Credits
MMS531	Practical Work - I	Geographic Information System & Remote Sensing	2
MMS532	Practical Work - II (in the field)	Tourism & Mountaineering: Concept & Practices	2
MMS581	Practical Work - III (in the field)	Mountaineering in Nepal (below Base Camp)	2

Total practical (indoors and field) course credits (E) 6

Research Works			
Code	Course Title	Course Covered	Credits
MMS631	Field Work - I (Research)	Mountain Safety Protocols (below 6000M)	2
MMS632	Field Work - II (Research)	Mountain Climate & Hydrology Glacial Geomorphology Dynamics of Snow, Ice & Glacier Mountain Ecology & Bio-diversity	4
MMS633	Case Study (Research)	Mountain Safety Protocol	1
MMS634	Case Study (Research)	Environmental Impact of Mountain Tourism	1
MMS649	Dissertation Proposal Seminar (Research)	MMS699: Dissertation	1
MMS697	Dissertation Defense (Research)	MMS699: Dissertation	9
MMS698	Publication of Scientific Article (Research)	MMS699: Dissertation	2
MMS699	Dissertation (Research)	MMS699: Dissertation	3

Total research works credits (F) 23

Total practical and research credits-G (E + F) 29

Semester I
Mountain Tourism & Mountaineering: Concept & Practices

Course Title: **Mountain Tourism & Mountaineering: Concept & Practices**

Course Cod: **MMS501**

Credit: 3 Hrs

Nature of Course: Theory (Compulsory)

Lecture: 45 Hrs

Course Overview

Mountain tourism and mountaineering as a form of adventure tourism covers the broad geographical diversity of the world and is one of the most niche areas of tourism development. The development of mountain and mountaineering tourism have created the environmental impacts on mountains that need to adapt mountaineering practices to limit the climate change ensuring benefits to local economy and participation of local people.

Learning Objectives: (General and Specific)

The overall objectives of this course is to acquaint the students about how mountaineering can follow sustainable practices in terms of sustainable mountain ecology, and development.

The specific objectives of the course are:

- to provide advanced knowledge on tourism development in mountain and mountaineering practices that adapt to sustainability of mountain ecology;
- to offer a critical eye toward adaptation and entrepreneurial innovation that ensures economic viability;
- to be able to understand about management system and its' necessities for mountaineering motivations, and mountaineering planning;
- to brand satisfaction for the future activities, people, and place to sustain tourism, creating a competitive destination.

Learning Outcomes

At the end of the course, students shall be able to:

- applicate the advanced knowledge on tourism development in mountain and mountaineering practices that adapt to sustainability of mountain ecology
- critically assess the aspects of tourism adaptation and entrepreneurial innovation ensuring economic viability
- function as a dynamic human capital ensuring satisfaction for future tourism and mountaineering

Course Content

Course	Units	Title/headings/subheadings	Lecture hours
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and Sub-Units		45 hrs
Unit 1: Mountains of the World	1.1 World Mountain ecosystems and tourism 1.2 The discovery of mountains as a destination 1.3 Mountain tourism's potential 1.4 Global mountain tourism destinations and trends 1.5 Visitors' behavior in mountain countries 1.6 The dynamics of structural change in mountain tourism 1.7 The popularization of mountain tourism 1.8 The industrialization of mountain tourism	10 hrs
Unit 2: Mountain and Tourism Activities	2.1 The characteristics of mountain destinations 2.2 Natural environment in mountain tourism 2.3 The characteristics of mountain tourism and activities 2.4 Perceptions of mountain tourism 2.5 Adventure sports, alpine wellness, leisure sports, and events 2.6 New trends creating mountain tourism potential 2.7 The nature of the mountain tourism market 2.8 The maturity of mountain tourism in the main markets	10 hrs
Unit 3: People, Communities, and Economics of Mountain Tourism	3.1 People and communities' participation in mountains tourism 3.2 The local aspects of mountain tourism 3.3 Public-private partnership as success factor 3.4 Threats and challenges for the mountain tourism economy	8 hrs
Unit 4: Opportunities for Mountain Tourism Development	4.1 The mountain tourism development models 4.2 The institutional framework of mountain tourism development 4.3 The need for favorable framework conditions 4.4 Entrepreneurship and local initiative as scarce resources 4.5 The externalities of mountain tourism growth	7 hrs
Unit 5: Mountain Tourism Destinations Case Studies	5.1 Mountaineering expeditions in Himalayas 5.2 Great trails of the world 5.3 Mountaineering activities in alps 5.4 Mountains resorts ice hotels 5.5 Alpine wellness 5.6 Rhaetian Railway, Switzerland	10 hrs

	5.7 El Caminito del Rey, Spain 5.8 Others	
Evaluation Scheme	<i>In-Semester</i>	40%
	<i>End-Semester</i>	60%
	<i>Total</i>	100%

References (Study Materials)

- Beedie, P. (2003). "Adventure Tourism." *Sport and Adventure Tourism*, 203–239.
[https://doi.org/10.1016/S0160-7383\(03\)00043-4](https://doi.org/10.1016/S0160-7383(03)00043-4)
- Buckley, R. (2006). *Adventure Tourism*, CAB International, UK, USA
- Buckley, R. (2010). *Adventure Tourism Management*, Butterworth-Heinemann, Elsevier, UK, USA pp 51-133
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https://www.alpinejournal.org.uk/Contents/Contents_1999_files/AJ%201999%20170-174%20Harper%20Annapurnas.pdf
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- Mountaineering Expedition Regulation, 2059 (2002 A.D. or updated) Ministry of Culture, Tourism and Civil Aviation. Singha Durbar, Kathmandu, Nepal
- Mountaineering Tourism (2015 or Updated), Edited by Ghazali Musa, James Higham and Anna Thompson-Carr, Routledge
- Musa, G., Hall, C. M., & Higham, J. E. (2004). Tourism sustainability and health impacts in high altitude adventure, cultural and ecotourism destinations: A case study of Nepal's Sagarmatha National Park. *Journal of Sustainable Tourism*, 12(4), 306-331.
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- Satyaj, Y. R. (1999). *Tourism in Nepal: a profile*. Adroit Publishers.
- Satyaj, Y. R. (2000). *Nepal an exotic tourist destination*, Delhi, Adroit Publisher
- Sustainable Mountain Tourism UNWTO

Swarbrooke, J., Beard, C., Leckie, S. and Pomfret, G. (2003).Adventure Tourism, The New Frontier, Butterworth-Heinemann, Elsevier, UK, USApp 1-35

Swarbrooke, J., Beard, C., Leckie, S. and Pomfret, G. (2003).Adventure Tourism, The New Frontier, Butterworth-Heinemann, Elsevier, UK, USA.

Tourism Act, 2035 (1978 A.D. or updated) Chapter-4 (Provisions Relating to Mountaineering) Ministry of Culture, Tourism and Civil Aviation. Singha Durbar, Kathmandu, Nepal

Tourism and Development in Mountain Regions, edited by P. M. Godde, M. F. Price, and F. M. Zimmerman. CABI Publishing, Wallingford and New York, 2000.

Mountaineering in Nepal

Course Title: **Mountaineering in Nepal**

Course Cod: **MMS502**

Nature of Course: Theory (Compulsory)

Credit: 3 Hrs

Lecture: 45 Hrs

Course Overview

This course intends to provide in-depth understanding of mountaineering in Nepal. It is focused on understanding the types of mountaineering operations in Nepal with contemporary trends in the world market. The course will enlighten the impact of mountaineering in socio-culture and economy of Nepal. This course will educate the students on developing sustainable mountaineering tourism activities and planning in Nepal.

Learning Objectives: (General and Specific)

The course in general, seeks to frame an academic picture of mountaineering and mountain tourism in Nepal, its constructive, history, practices and mountaineering future development enveloped with sustainability.

Specific objectives of the course are to:

- define mountain, mountaineering and mountain tourism;
- discuss mountaineering trend in Nepal and the world;
- analyze the impacts of mountaineering tourism;
- explain sustainable mountain tourism development;
- plan the mountaineering activities in Nepal;
- develop marketing strategy for mountaineering in Nepal.

Learning Outcomes:

Upon successful completion of this course, the students will be able to gain on the sustainable mountaineering in Nepal. Students will also be able to analyze the impacts of mountaineering operation in the Nepal Himalaya.

The key learning outcomes of the course will be as below.

Knowledge and understanding of:

- mountains, mountaineering, and mountain tourism in Nepal;
- the contribution of mountaineering in tourism industry;
- analysis of impact of mountaineering activities in economy and society together with cultural change;
- sustainable mountaineering operation in Nepal;
- involvement of tourism and mountaineering organizations.

Course Content

Course and Sub-Units	Units	Title/headings/subheadings	Lecture hours
			45 hrs
Unit 1: History of Mountaineering		1.1 Mountaineering and mountain tourism 1.2 History of Indian Subcontinent mapping & discovery of highest peaks in Himalayas 1.3 Exploration of Himalayan peaks and Sagarmatha (Mt. Everest) 1.4 History of mountaineering in Nepal: Understanding mountaineering development in Nepal 1950 – 2021)	8 hrs
Unit 2: Mountaineering Types in Nepal		2.1 Mountaineering expeditions in Himalayas 2.2 Organized mountaineering 2.3 Alpine style mountaineering 2.4 Solo mountaineering	5 hrs
Unit 3: Comparative Analysis of Mountaineering		3.1 Mountaineering trends in Nepal & the world scenario - Facts & figure of DOT (Department of Tourism) - Nepalese perspective in mountaineering 3.2 Trends in mountain tourism	4 hrs
Unit 4: Sustainability Development in Mountaineering Tourism		4.1. Mountaineering impacts in environment, economy, society, and culture 4.2. Mountaineering and livelihood of mountain people 4.3. Impact of mountaineering tourism - Environment - Socio-cultural - Economy - Contribution in national GDP - Multiplier effects - Regional development - Employment opportunity - Social understanding - Cultural exchange 4.4. Preservation and revival of culture 4.5. Sustainable mountaineering tourism 4.6. Mountain and mountaineering environment 4.7. Mountaineering and environment pollution: - Litter and waste pollution/impact of management practices and regulations in Nepal - Cleaning campaign	8 hrs

<p>Unit 5: Marketing & Promotion of Mountaineering</p>	<p>5.1 Introduction of mountaineering promotion - Importance of mountaineering promotion - Mountaineering promotion planning - Mountaineering meets/ conferences/ workshop - Travel Mart: ITB Berlin, WTM London, Fiture Spain, HTM Nepal, BITM Nepal - Road show - Travel mission - Public relation</p> <p>5.2 Promotional campaign and marketing - Mountaineering branding - Mountaineering marketing strategy - Visit Nepal 1998 - Nepal tourism year 2011 - Visit Nepal 2020</p>	<p>6 hrs</p>
<p>Unit 6: Role of Different Organizations in Mountaineering</p>	<p>6.1 International organizations - United Nations World Tourism Organization - World Travel and Tourism council - International Federation of Mountain Guide Association (IFMGA) - Union of Asian Alpine Association (UAAA) - International Climbing & Mountaineering Federation (UIAA) - Adventure Travel Trade Association (ATTA) - Pacific Asia Travel Association (PATA)</p> <p>6.2 National Organizations - Ministry of Culture, Tourism, and Civil Aviation - Department of Tourism - Nepal tourism Board - Nepal Mountain Academy - Nepal Mountaineering Association (NMA) - Nepal National Mountain Guide Association (NNMGA)</p> <p>6.3 INGOs/NGOs: World Conservation Union, World Wildlife Funds, and International Center for Integrated Mountain Development (ICIMOD)</p>	<p>6 hrs</p>

Unit 7: Mountaineering Operation in Nepal	7.1 Mountaineering expedition planning	8 hrs
	7.2 Procedure for mountaineering and climbing	
	7.3 Leadership and risk assessment	
	7.4 Reporting system	
	7.5 Responsibility of operators, mountaineers, mountain guide, liaison officer	
	7.6 Garbage management mechanism in mountain and mountaineering	
	7.7 Insurance policy, system and mechanism in mountaineering	
	7.8 Inspiration to implementation: the more technical routes	
Evaluation Scheme	<i>In-Semester</i>	40%
	<i>End-Semester</i>	60%
	<i>Total</i>	100%

Basic Text Books

Mountaineering Tourism (2015 or Updated), Edited by Ghazali Musa, James Higham and Anna Thompson-Carr, Routledge

Government of Nepal. (2020 onwards). *Mountaineering in Nepal Facts & Figure*, Ministry of Culture, Tourism and Civil Aviation. Singha Durbar, Kathmandu, Nepal

Tourism Act, 2035 (1978 A.D. or updated) Chapter-4 (Provisions Relating to Mountaineering) Ministry of Culture, Tourism and Civil Aviation. Singha Durbar, Kathmandu, Nepal

Mountaineering Expedition Regulation, 2059 (2002 A.D. or updated) Ministry of Culture, Tourism and Civil Aviation. Singha Durbar, Kathmandu, Nepal

Satyal, Y. R. (2000). *Nepal an exotic tourist destination*, Delhi, Adroit Publisher

Satyal, Y. R. (2000). *Tourism in Nepal, A profile*, Delhi, Adroit Publisher

Reading Materials

Satyal, Y. R. (2000), *Tourism in Nepal, A profile*, Delhi, Adroit Publisher (pp.82-86)

Satyal, Y. R. (2000), *Nepal an exotic tourist destination*, Delhi, Adroit Publisher (pp.126-135)

Nepal, Pramod,(2018) *Mountain Economics*, in *Voice of Himalaya*,(pp. 36-38), Nepal Mountain Academy, Kathmandu

Sharma, Pitamber,(1995) *Tourism for local community development in Mountain Areas: Perspectives, Issues and Guidelines*, (pp.56-68), ICIMOD, Kathmandu,

Shakya, Vinaya (2018) *Mountaineering Training in Nepal*, *Voice of Himalaya*,(pp. 54-55), Nepal Mountain Academy, Kathmandu

Nepal, Sanjay K.(2003) *Tourism and Environment, Perspective from Nepal Himalaya*, pp.(25-52) Himal Books, Lalitpur Nepal

Patricia East, Kurt Luger, Karin Inmann (1998), Sustainability in Mountain Tourism, Perspective for the Himalayan Countries,(pp 29-46) Oeko Himal Publication, Book Faith Delhi, India
Voice of Himalaya. (2018) Nepal Mountain Academy, Kathmandu
Philip T. Kotler, John T. Bowen, James Makens Ph.D., Seyhmus Baloglu, (2017) Marketing for Hospitality and Tourism, Pearson Education Limited, England

Mountain Geography

Course Title: **Mountain Geography**

Course Cod: **MMS503**

Nature of Course: Theory (Compulsory)

Credit: 3 Hrs

Lecture: 45 Hrs

Course Overview

The course incorporates a vivid account of the Geography of Nepal Himalaya. Nepal's geography, an astounding craft if nature it is, is the hotspot of several earthly phenomenon and world's most amazing geographical diversity, on which the course seeks to enlighten students on utilizing the geographical prospects on tourism. Inclusions of the course are introduction to mountain geography, climate, hydrology and other geographic phenomenon, mountain specificities, ecology, culture, and sustainable development of mountain tourism in the Nepal Himalaya.

Learning Objectives: (General and Specific)

The general objective of this course is to provide knowledge on mountain geography from the prospective of mountain sciences, mountain people and mountain development. After completing the course, it enables students to comprehend, analyze, and utilize the knowledge gained and expected to apply the knowledge for sustained mountain development. It is expected that it helps to produce competent human resources to deal with the issues and problems of mountain areas with focus on mountain tourism and mountaineering.

Specific Objectives:

The specific objectives of the course are:

- to provide explicit knowledge on: Mountain geography- formation; types; distributions; structure- geological formation; soils; climate; vegetation; hydrology; ecology; land use; landforms and geomorphic processes; mountain people, economy and culture;
- to make students familiar with mountain specificities and occurring phenomenon;
- to utilize geographical competency to develop mountain tourism with focus on Himalayas in general and Nepal Himalayas in particular simultaneously considering sustainability and conservation.

Learning Outcomes

At the end of the course, students will be able to:

- grasp a complete overview on the geographic setting of the Nepal Himalaya
- observe, calculate and analyze mountains' happenings;

- build concrete base of innovation and advancement of mountain tourism on the Nepal Himalaya's geographical competency.

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours 45 hrs
Unit 1: Introduction to Mountain Geography	1.1 Definition and perception about mountains 1.2 Role/significance of mountain areas in general 1.3 Major mountain ranges and their characteristics in the world 1.4 The Hindu-Kush Himalayan mountain: Distribution, geological structure, tectonic activities 1.5 Nepal Himalayas: Physiographic regions – distribution, characteristics, ecological regions, agro-ecological regions	4 hrs
Unit 2: Origins and Types of Mountains	2.1 Theories of mountain origin, 2.2 The plate tectonics, 2.3 Global typology of mountain classes	3 hrs
Unit 3: Mountain Climate and Hydrology	3.1 Role of mountain in climate variation: <ul style="list-style-type: none"> - Spatial variation in climate and weather condition - Modification: orographic influence, barrier effect etc 3.2 Characteristics of mountain weather and climate: Altitudinal and latitudinal variations 3.3 Characteristics of mountain hydrology and cascading process with example from Nepal Himalayas	6 hrs
Unit 4: Mountain Landforms and Geomorphic Processes	4.1. Brief introduction of mountain landforms and geomorphic processes <ul style="list-style-type: none"> - Landscape and their development - Hillslope components - Weathering: Physical weathering, chemical weathering - Frost-related features and processes - Permafrost - Needle Ice 4.2. Mass wasting: Creep, solifluction, mudflows, slumping, rockfalls 4.3. Landslides and debris avalanches	6 hrs

	4.4. Features of mass wasting 4.5. Soil erosion	
Unit 5: Mountain Soils	5.1 Brief introduction of mountain soils 5.2 Soil-forming factors 5.3 Major kinds of mountain soils 5.4 Soil classification 5.5 Potential and limitations of mountain soils	4 hrs
Unit 6: Mountain Flora, Fauna and Land Use	6.1 Characteristics and distribution of flora and fauna in mountain areas 6.2 Ecological diversities 6.3 Vegetation zones 6.4 Major land use pattern	4 hrs
Unit 7: Mountain People, Economy and Culture with Specific Reference to Nepal Himalayas	7.1 Population characteristics of mountain area: Growth, density, distribution, age-sex composition, occupation, education, migration 7.2 Human settlements and urbanization 7.3 Economy: - Sedentary agriculture - Agroforestry - Shifting cultivation - Livestock grazing and pastoralism - Nomadic pastoralism - Transhumance - Remittance 7.4 Livelihoods of mountain people - Living with risks - Resilience of mountain people	6 hrs
Unit 8: Mountain Specificities	8.1 Mountain Specificities: - Inaccessibility - Fragility - Marginality - Diversity/Heterogeneity - Niche/comparative advantage - Human adaptation mechanism	6 hrs
Unit 9: Sustainable Development of Mountain and Mountain	9.1 Service infrastructure in the mountain areas 9.2 Development challenges and opportunities in the mountain area 9.3 Indicators of sustainable development - Economic sustainability	6 hrs

Tourism	<ul style="list-style-type: none"> - Sociocultural sustainability - Ecological sustainability 9.4 Strategic issues in sustainable mountain and mountain tourism development 9.5 Development and conservation linkages in mountain areas 9.6 National, regional and global initiation for sustainable mountain development in general and mountain tourism in particular 9.7 Integrated strategy for long-term mountain and mountain tourism development	
Evaluation Scheme	<i>In-Semester</i>	40%
	<i>End-Semester</i>	60%
	<i>Total</i>	100%

Text Books and References Material

- Aber, J.S., Marzloff, I. and Ries, J.B. (2010). Small-Format Aerial Photography: Principles, Techniques and Geoscience Applications. Elsevier, p.261.
- Bishop, M. P. (2009). International multidisciplinary research and education: A mountain geography perspective. *Journal of Geography*, 108(3), 112-120.
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- Cunha, S. F., & Price, L. W. (2013). 11. Agricultural Settlement and Land Use in Mountains. In *Mountain Geography* (pp. 301-332). University of California Press.
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- Ives J. D. Ives and Messerli, B. (1989) The Himalayan Dilemma: Reconciling Development and Conservation. ROUTLEDGE London and New York
- Ives, J.D. (2006) Himalayan Perceptions: Environmental change and the well being of mountain people, Kathmandu: HimAAS.
- Janke, J. R., & Price, L. W. (2013). 5. Mountain Landforms and Geomorphic Processes. In *Mountain Geography* (pp. 127-166). University of California Press.
- Jodha, N. S. (1990). A framework for integrated mountain development. ICIMOD, Lalitpur, Nepal.
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- John F. Shroder and Tim Davies (2015). Landslide Hazards, Risks, and Disasters. Elsevier, p. 475.
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- Price, L. W., & Harden, C. P. (2013). 6. Mountain Soils. In *Mountain Geography* (pp. 167-182). University of California Press.
- Price, M. F. (2013). *Mountain geography: Physical and human dimensions*. University of California Press.
- Price, M. F., & Kohler, T. (2013). 12. Sustainable Mountain Development. In *Mountain Geography* (pp. 333-366). University of California Press.
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Mountain Climate & Hydrology

Course Title: **Mountain Climate & Hydrology**

Course Cod: **MMS504**

Nature of Course: Theory (Compulsory)

Credit: 3 Hrs

Lecture: 45 Hrs

Course Overview

This course outlines the basic knowledge on high altitude meteorology, weather system in mountains, hydrology, and its impact on climate change, water resources planning, development, and management.

Learning Objectives: (General and Specific)

The objectives of the course are:

- to strengthen knowledge on hydro-meteorological phenomenon, the hydrological cycle, catchment hydrology, and snow/glacier hydrology;
- to enhance understanding on fundamentals of climate change, variability, and climate change impact assessment on mountain hydrology;
- to broaden knowledge on managing mountain hydrology and water resources in the changing context.

Learning Outcomes

By the end of this course, students will be able to identify and describe the weather system, meteorology, hydrology, and climate change of mountainous region.

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours 45 hrs
Unit 1: Introduction	1.1. The global hydrological cycle (storage, fluxes, and resident times), and high-altitude water cycle 1.2. Mountains as a water towers and driver of hydrological cycle 1.3. Weather, climate, climate change/variability, meteorology, and cryosphere 1.4. Development of hydro-meteorological study in Nepal	3 hrs
Unit 2: Mountain Climate	2.1 Factors determining climate: Latitude, altitude, continuity, and regional circulation 2.2 Meteorological variables (definition, importance, and measurement/estimation) – precipitation, atmospheric moisture, temperature, wind, radiation/energy-balance,	3 hrs

	<p>vapor pressure, humidity, thermal stratification</p> <p>2.3 Atmospheric stability and cloud formation: Stable and unstable atmosphere, causes of instability, formation of dew/frost/fog, classification and identification of clouds, cloud modifications</p> <p>2.4 Climatic classification of Nepal: Need and objectives of classifications, various types of classification approaches (e.g., Koppen's classification, Thornthwaites classification), climatic classification of Nepal</p>	
Unit 3: Catchment Hydrology	<p>3.1 Catchment water balance – Precipitation, Interception and Evapotranspiration losses, Infiltration/percolation, Surface runoff, Water balance analysis, factor affecting runoff</p> <p>3.2 Hydrological measurements – Various methods for discharge measurements (e.g., current meter, float, dilution, etc.), rating curve, selection of site for hydrological measurement,</p> <p>3.3 Hydrograph analysis – understanding and application of various methods and their applicability/limitations</p> <p>3.4 Catchment hydrological modeling – fundamentals of hydrological modeling, available modeling tools (e.g., HEC-HMS, ABCD)</p>	12 hrs
Unit 4: Snow Hydrology	<p>4.1. Understanding snow, ice and glaciers – definitions and types, snow/glacier lines and their importance, snowpack characterization (density, thermal quality, liquid water content, albedo, snow water equivalent (SWE), etc.)</p> <p>4.2. Snow measurement/estimation techniques – field-based and remote-sensing methods</p> <p>4.3. Snow accumulation, melting, flow of meltwater (including routing through snowpack), and snowmelt hydrograph</p> <p>4.4. Snow melt runoff modeling – lumped models, distributed models, energy balance-based models, temperature index-based models, physiographic and climatic controls on modeling</p>	6 hrs
Unit 5: Glaciology	<p>5.1 Fundamentals of glaciology - Global glacial chronologies and causes of glaciation; glacial surface</p>	6 hrs

	<p>structure and its characterization</p> <p>5.2 Hydrology of glacier – glacier melt water system, glacial hydraulic systems (e.g., Supra, Englacial, sub-glacial), glacial mass balance studies (e.g., ice core studies, glacial dating, modeling, etc.)</p> <p>5.3 Glacial movements – avalanche, crevasses, depth hoar, Glacier Lake Outburst Floods (definition, mechanisms, incidences/events (history), and mitigation measures).</p> <p>5.4 Glaciers of Nepal</p>	
Unit 6: Climate Change Impacts on Mountain Hydrology	<p>6.1 Climate change basics – climate models (GCMs and RCMs), climate change scenarios, climate downscaling/bias correction, and IPCC reports/assessments,</p> <p>6.2 Climate change impacts assessment on cryosphere and catchment water availability</p> <p>6.3 Uncertainties in climate change impact assessment</p> <p>6.4 Mitigation and adaptation to climate change, with specific reference to hills and mountains</p>	9 hrs
Unit 7: Human Impacts (Direct and Indirect) on Mountain Hydrology	<p>7.1 Dams and flow regulations (direct)</p> <p>7.2 Off-channel diversions (direct)</p> <p>7.3 Land use/cover changes - Urbanization (indirect) and Deforestation (indirect)</p> <p>7.4 Others (e.g., grazing and cropland agriculture, road construction, etc.)</p>	3 hrs
Unit 8: Managing Hydrological Cycle and Water Resources in the Changing Context	<p>8.1 Water storage – reservoirs, rainwater harvesting, groundwater recharge, soil moisture storage, etc.</p> <p>8.2 Environmental flows (E-flows) – considering downstream water needs</p> <p>8.3 Water resources planning and management</p> <p>8.4 Water governance (policy, institutions, legal frameworks, etc.)</p>	3 hrs
Evaluation Scheme	<i>In-Semester</i> 40%	
	<i>End-Semester</i> 60%	
	<i>Total</i> 100%	

References (Reading materials/ required and references)

Acharya, K. P., Dangi, R. B., Tripathi, D. M., Bushley, B. R., and Bhandary, R. R. (2009). (Eds.). Ready for REDD? Taking stock of experience, opportunities and challenges in Nepal. Nepal Foresters' Association, Kathmandu.

- Barry, Roger G., Second edition, Mountain weather and climate (2001) Routledge Publication
- Bhujju, D. R., Yonzon, P. B. and Baidya, B., 2007. Landscape Pattern and its Changes in the Churiya, Eastern Nepal. *Ecoprint* 14: 65-71.
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- Harvey, L. D. D. (2010). *Global warming: the hard science*. Pearson Education Limited, Harlow.
- Houghton, J. (2004). *Global warming: the complete briefing*. Cambridge University Press, Cambridge.
- ICIMOD, 1993. *Mountain Environment and Development*. Proceedings of the Tenth Anniversary Symposium of ICIMOD, Nepal. ICIMOD, Kathmandu.
- IPCC. (2002). *Climate change and biodiversity*. Intergovernmental Panel on Climate Change, Geneva.
- IPCC. (2006). *Guidelines for national greenhouse gas inventories*. Intergovernmental Panel on Climate Change, Geneva.
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- Lal, D.S. (2020). *Climatology*. Sharda Pustak Bhawan, Allahabad.
- McGuffie k., and A. Henderson-Sellers,(2005) *A Climate Modelling Primer*, Third Edition. John Wiley & Sons, Ltd ISBN: 0-470-85750-1 (HB); 0-470-85751-X (PB).
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- Oke. T. R. *Boundary Layer Climates*, Second edition (1987) Routledge publication

- Poudel, K.C., 2003. Watershed Management in the Himalayas: A Resource Analysis Approach. Adroit Publishers, Delhi.
- Reddy, J. R. (2001) A Text Book of Hydrology. Laxmi Publications P. Ltd., New Delhi.
- Rhoades, R. E., 2007. Listening to the Mountains. Kendall/Hunt Publishing Company.
- Smith, J. and Peake, S. (2009). Climate change from science to sustainability. Oxford University Press, Oxford.
- Subramanayam, K. (2008) Engineering Hydrology; TATA McGraw Hills Publications Ltd., New Delhi.
- Whiteman, C. David. Mountain Meteorology, Fundamentals and Applications, (2000), Oxford University Press
- World Meteorological Organization (WMO). Statement on the State of the Global Climate in 2019, Chair, Publications Board WMO, 7 bis, avenue de la Paix P.O. Box 2300 CH-1211 Geneva 2, Switzerland

Research Methodology

Course Title: **Research Methodology**

Course Cod: **MMS505**

Nature of Course: Theory (compulsory)

Credit: 2 Hrs

Lecture: 30 Hrs

Course Overview

This course is designed to provide graduate-level students with an appreciation of the role of research in education and the application of various tools and techniques to conduct research. It is intended for students to be equipped with a basic knowledge of the scientific method and background of introductory statistics.

Learning Objectives: (General and Specific)

The general goal of the course is to provide students with a decent understanding of the philosophy of research, scientific research procedure, research types and designs, methods of data and information collection, data handling and analysis in the field of mountaineering and mountain sciences. The specific objectives of the course are to:

- Provide a clear notion of research, approaches to conducting research and its importance in education as well as in day-to-day life;
- Elucidate various types of research and concepts of research design;
- Explain the different approaches of data collection and sampling;
- Provide an understanding of data collation, management and presentation;
- Impart knowledge and skills related to various statistical data analysis (quantitative parametric and non-parametric) techniques and inferences to be drawn from the analyses.

Learning Outcomes

The specific learning outcomes upon completion of the course are that students will be able to:

- Clearly understand the purpose and principles of research;
- Understand the scientific procedure and set up research questions and hypotheses;
- Plan and conduct effective search strategies to retrieve, evaluate and identify useful sources; review of literature and proposal preparation;
- Devise methods appropriate to the questions or hypotheses of a research topic;
- Integrate and present, both orally and in writing, research information in a coherent and logical form with correctly cited references;
- Gain knowledge about data collection through appropriate sampling, and manage as well as evaluate the data;
- Conduct basic statistical tests of the data and make appropriate inferences and interpretation of results.

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours 30 hrs
Unit 1: Introduction	1.1 Basic concepts, research types and objectives 1.2 Philosophical worldviews 1.3 Strategies of inquiry 1.4 Need and importance of research in mountain environments	2 hrs
Unit 2: Research Approaches and Styles of Inquiry	2.1 Qualitative, quantitative and mixed methods 2.2 Ontology and epistemology 2.3 Conceptual/theoretical frameworks 2.4 Research design 2.5 Induction/deduction and theory placement 2.6 Formulation of research questions/hypotheses	4 hrs
Unit 3: Sampling and Data Collection	3.1 Sampling techniques (probability and non-probability) 3.2 Sample size determination 3.3 Data collection 3.4 Survey design, interview, observation/ethnography, case study, PRA, focus group discussion	6 hrs
Unit 4: Methods for Quantitative Research	4.1. Experimental design 4.2. Randomization 4.3. Variable types (categorical – nominal/ordinal 4.4. Quantitative – discrete/continuous) 4.5. Basic statistics (probability, normal distribution, central tendency, variance, standard deviation, standard error) 4.6. Exploratory data analysis (univariate; multivariate; graphical/non-graphical)	8 hrs
Unit 5: Experimental Design and Data Analysis	5.1 Means comparisons 5.2 Non-parametric – Chi square test of independence 5.3 Wilcoxon rank sum test 5.4 Parametric: two sample or paired t-test 5.5 Analysis of variance (one-way and two-way) 5.6 Fisher's Least Significant Difference for pair-wise means comparison 5.7 Linear/non-linear regression and Pearson's correlation analysis	8 hrs
Unit 6: Research	6.1 Research project planning 6.2 Proposal/project components:	2 hrs

Proposal and Project Preparation	<ul style="list-style-type: none"> - Introduction/ background - Statement of the problem - Goals/ objectives - Significance - Limitation - Activities & implementation - Literature review - Methods <p>6.3 Logical framework 6.4 Gantt chart 6.5 Budget 6.6 Citation and referencing</p>							
Evaluation Scheme	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><i>In-Semester</i></td> <td style="text-align: right;"><i>40%</i></td> </tr> <tr> <td><i>End-Semester</i></td> <td style="text-align: right;"><i>60%</i></td> </tr> <tr> <td><i>Total</i></td> <td style="text-align: right;"><i>100%</i></td> </tr> </table>		<i>In-Semester</i>	<i>40%</i>	<i>End-Semester</i>	<i>60%</i>	<i>Total</i>	<i>100%</i>
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Textbooks & References (Reading materials required and references)

- Creswell, J. (2013). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Publisher: SAGE Publications, Inc
- Flint, G. C. (2016). Framing the Human Dimensions of Mountain Systems: Integrating Social Science Paradigms for a Global Network of Mountain Observatories. <https://bioone.org/journals/mountain-research-and-development/volume-36/issue-4/MRD-JOURNAL-D-15-00110.1/Framing-the-Human-Dimensions-of-Mountain-Systems--Integrating-Social/10.1659/MRD-JOURNAL-D-15-00110.1.full>
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- Kumar, R. (2011). Research Methodology: A step-by-step guide for beginners (3rd edition). London, UK: TJ International Ltd, Padstow, Cornwall
- Leedy, P. D. (1980). Practical Research: Planning and Design. Washington: Mc Millan Publishing Co., Inc.
- Price, M. F. (2014). Mountain Area Research and Management: Integrated Approaches. Published August 15 by Routledge, SBN 9781138002029.
- Seltman, H. (2018) Experimental Design and Analysis. <http://www.stat.cmu.edu/~hseltman/309/Book/Book.pdf>; associated data files are at <http://www.stat.cmu.edu/~hseltman/309/Book/data/>.
- Wallinman, N. (2006). Your Research Project: A step-by-step guide for the first-time researcher. London: Sage Publications

Geographic Information System & Remote Sensing

Course Title: **Geographic Information System & Remote Sensing**

Course Cod: **MMS506**

Credit: 2 Hrs

Nature of Course: Theory (Compulsory)

Lecture: 30 Hrs

Course Overview

This course “Geographic Information System and Remote Sensing” is designed for M. Sc. in MMS. The focus of the course is to provide theoretical/conceptual knowledge and practical skills on geospatial sciences about mountain specificities required for mountaineering professionals and scientists. The course is aiming to prepare professional and skillful, innovative, creative and constructive mountaineers and mountain related human resources for the country and abroad. It covers different aspects of Geo-Information Sciences (GIS and remote sensing) which include introduction to Geo-Information Sciences (GI Sciences), Mapping Basics, Fundamentals of Remote Sensing (RS) and Global Positioning Systems (GPS), RS Sensors and their characteristics, Interpretation of Satellite Imagery and Image Processing Systems, GIS, GPS and RS data integration and database management, geo-processing, analysis, sharing and networking.

Learning Objectives: (General and Specific)

The course includes an overview of the principles, concepts, theories and practical applications of Geographical Information System (GIS), Global Positioning Systems (GPS) and Remote Sensing (RS). At the end of the course, students/learners will be able to fulfill the following specific objectives:

- Understand fundamental concepts, scope and application of Geo-information (GIS, GPS and RS) in mountaineering and mountains sciences;
- Familiarize with the different aspects of geospatial characteristics and information about the mountaineering and mountains;
- Handle different types of geospatial data and database management;
- Apply various knowledge, techniques, and skills of Geo-information required for mountaineering and mountain sciences.

Learning Outcomes

This course has been designed within the framework of complementary learning purposes for the MMS students on theoretical and conceptual parts. The practical and hands-on exercises based on theoretical and conceptual ground cover in practical. Therefore, the learning outcomes of the course expect students/learners achieve better understanding on theory and concept of the mountain specificities and mountaineering technologies with the support of computer-based Geo-Information Systems and space borne mapping technologies, GI Science capabilities, and

enabling environments. After the completion of the course, students/learners achieve the following measurable learning outcomes:

- Introduced with geo-Information systems, learned mapping basics and spatial data concepts and peripherals;
- Built knowledge on fundamentals of Photography, Remote Sensing, GPS and unmanned aviation/aerial vehicles (UAV) (Drone) space technologies for data acquisition systems and basic characteristics of RS sensors sensing systems;
- Enhanced technical skills for interpretation of Satellite Imagery and Image Processing Systems;
- Acquainted with conceptual grounds for the techniques on GIS, GPS and RS data integration and analysis of mountain geographical features and output design using those data/information and dissemination.

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours 30 hrs
Unit 1: Introduction to Geo-Information Sciences (GIS)	1.1. Basic concepts <ul style="list-style-type: none"> - Spatial thinking, geography matters and concepts - Fundamentals of GI Science and its functions - Components of GIS and RS 1.2. Geographic data <ul style="list-style-type: none"> - Concept of geographic data and information - Concepts of measurement scale and database management - GI data infrastructure, meta data, data interoperability and data policy (data creation, storage, value addition, sharing, right to information) 1.3. Historical development of applications of GI Sciences <ul style="list-style-type: none"> - From static (analog) mapping to digital mapping - Online mapping and Web GIS 	4 hrs
Unit 2: Mapping Basics	2.1 Elements of analog and digital maps <ul style="list-style-type: none"> - Scale - Coordinate system - Projection - Map symbols, legends, color 2.2 Types of map and representation systems <ul style="list-style-type: none"> - General small-scale maps and large-scale maps 	3 hrs

	<ul style="list-style-type: none"> - Thematic small-scale maps and large-scale maps - Representation of spatial features, contour, social and development activities and their interpretation about the mountains - Representing qualitative and quantitative information 	
Unit 3: Spatial Data Concepts	<p>3.1 Spatial data sources</p> <p>3.2 Spatial data models and structures (vector and raster)</p> <p>3.3 Attribute data type</p> <p>3.4 Data precision, resolution and errors</p> <p>3.5 Data quality control, storage, management and sharing</p>	4 hrs
Unit 4: Fundamentals of Photography, Remote Sensing, GPS and Unmanned Aviation/Aerial Vehicles (UAV) (Drone)	<p>4.1 Photographic Systems (panoramic, oblique, vertical)</p> <p>4.2 Introduction to Remote Sensing (RS) and satellite navigation</p> <ul style="list-style-type: none"> - Fundamental principles of RS and spatial data capture process - Energy matter interaction, spectral reflectance, spectral signature <p>4.3 Global Positioning Systems and UAV</p> <ul style="list-style-type: none"> - Unmanned Aviation/aerial Vehicles (UAV) and imaging systems for spatial information capture - Drone and LiDAR imaging system - Application of RS, GPS and UAV for spatial data creation at the mountain landscape 	4 hrs
Unit 5: RS Sensors and their Characteristics	<p>5.1 Satellite system and sensors characteristics of optical, infrared and microwave sensors and data products</p> <p>5.2 Type of Image Resolution</p>	4 hrs
Unit 6: Interpretation of Satellite Imagery and Image Processing Systems	<p>6.1 Elements of Image interpretation</p> <p>6.2 Image processing</p> <ul style="list-style-type: none"> - Visual image processing - Digital image processing (DIP) - Preparation of digital map from the image data 	4 hrs
Unit 7:	7.1 Geo-processing concepts	4 hrs

GIS, GPS and RS Data Integration and Analysis of Mountain Geographical Features	7.2	Spatial data overlay (raster overlay and vector overlay)	
	7.3	Concept of spatial data interpolation (spot heights, temperature, precipitation)	
	7.4	Concept of 3-D spatial data, digital elevation model/digital terrain model	
Unit 8: Output Design and Dissemination	8.1	Concept of digital map design	3 hrs
	8.2	Map output, interpretation	
	8.3	Authenticity, sharing, copyright and plagiarism	
Evaluation Scheme	<i>In-Semester</i> 40%		
	<i>End-Semester</i> 60%		
	<i>Total</i> 100%		

Text Books and References (Reading materials/ required and references)

- George, J., and Jeganathan, C. (2018). *Fundamentals of Remote Sensing*. Third Edition. Hyderabad, Telangana, (3rd Edition) Universities Press.
- Goodchild, Michael F. (2004). GIScience, Geography, Form, and Process. *Annals of the Association of American Geographers*, 94(4):709–714
- ICIMOD (2009) Mountain GIS: Promoting Geographic Information and Earth Observation Applications for the Sustainable Development of the Hindu Kush Himalayan Region. E-Conference Report. Kathmandu: The Mountain Forum.
- Joseph K. Berry (1996) Beyond Mapping: Concepts, Algorithms and Issues in GIS. ISBN: 978-0-470-23676-5
- Lillisand T. M. and Keifer, R.W. (2000). *Remote Sensing and Image Interpretation*. (7th Edition) New York: John Willey.
- Lo, C.P. and Yeung, K.W. Albert (2002). *Concepts and Techniques of Geographical Information Systems*. London: Prentice Hall.
- Michael D. Kennedy (Author), Michael F. Goodchild (Afterword), Jack Dangermond (Foreword)(2013), *Introducing Geographic Information Systems with a ArcGIS: A Workbook Approach to Learning GIS*. 3rd edition, ISBN-13: 978-1118159804, ISBN-10: 1118159802 Wiley.

References (Reading materials/ required and references)

- de Smith, MJ., Goodchild, MF., and Longley, PA (2018). *Geospatial Analysis: A Comprehensive Guide*., London, The Winchelsea Press Ltd.
- Heywood, I. Sarah Cornelius and S Carter (2006). *An Introduction to Geographic Information Systems, Third Edition*. Harlow, England, Pearson Education Limited.

- Longley, PA., Goodchild, MF., Maguire, DJ., and Rhind, DW (1999). *Geographical Information Systems: Volume 1 Principles and Technical Issues*. Second Edition. John Wiley & Sons, Inc.
- Lwin, KK., (2008). *Fundamentals of Remote Sensing and its application in GIS*. Division of Spatial Information Science, University of Tsukuba, Japan.
- n.d. (2012). *Geographic Information System Basics v.1*. <http://2012books.lardbucket.org/eBook>.
- Tempfli, K., Norman, K., Huurneman, GC., and Janssen, LLF., (eds.) (2009). *Principles of Remote Sensing: An Introductory Textbook*. ITC Text Book Series 2, Fourth edition. Enschede, The Netherlands.

Suggested reference journals for reading

- International Journal of Geographical Information Science
- International Journal of Remote Sensing
- ISPRS Journal of Photogrammetry and Remote Sensing
- Journal of Applied Remote Sensing
- Journal of Geographic Information System
- Journal of Spatial Science
- Publications of Nepal GIS Society
- Remote Sensing of Environment

Practical Work - I

Course Title: **Practical Work - I**

Course Cod: **MMS531**

Credit: 2 Hrs

Nature of Course: Practical (Compulsory)

Lecture: 90 Hrs

Course Overview

This course MMS531 is based on the practical part of theory course "MMS506 Geographic Information System and Remote Sensing". The course aims at meeting the practical standards of GIS and remote sensing based on the theoretical foundation of the subject. The course includes Geo-referencing, GIS Data (Spatial and attribute) preparation, Spatial Analysis in GIS, Aerial Photo and Photogrammetry, Image Data Format and Statistics, Digital Image Processing (DIP), Image Classification, Global Positioning System, and Map Layout. It thus focuses on providing practical hands-on exercise skills and techniques on geospatial sciences about mountain specificities required for mountaineering professionals and scientists. The course further seeks to prepare professional and skillful, innovative, creative and constructive mountaineers and mountain related human resources for the country and abroad. The course is designed to handle computer-based digital data handling, processing and mapping software. It covers both GIS and image handling software required for both models of the digital data.

Learning Objectives: General and Specific Objectives

The course aims at providing the idea of data collection/compilation, vectorization, error minimization and quality checking for precision, geo-processing, analysis, management and output design, and finally for dissemination and networking.

Specific Objectives

The course specifically aims at enabling:

- Geographical data (vector data) analysis, preparation, integration, and projection;
- Geo-processing with 3D Geo-modeling, processing, network analysis, overlay analysis, and 3D map projection;
- Image data formatting and Digital image processing at the strengths of satellite image exercises;
- Navigation through the GPS and map layout maneuver.

Learning Outcomes

This course is the practical hands-on exercise part of the course code 516. Therefore, the learning outcomes of the course specifically based on hands-on exercises built on the theoretical and conceptual ground within the relevant computer software environment. Learning outcomes of the course expect students/learners achieve better understanding on practical part of the mountain specificities and mountaineering technologies with the support of computer-based Geo-

Information Systems as well as air and space borne mapping technologies. After the completion of the course, students/learners achieve the following measureable learning outcomes:

- Enabled to transform real earth geographic features to global referencing system (GRS);
- Handled GIS Data (both spatial and attribute) to create, store, manage, analyze, output design and disseminated in computer software environment;
- Learned techniques on mountain specific spatial analysis including geo-processing, neighborhood analysis, network analysis, overlay analysis, interpolation and 3-D map preparation;
- Enabled interpretation and mapping mountain geographic features acquired by aerial photo, satellite image and GPS systems and dissemination for the application of mountaineering purposes.

Practical Course Content

Content	Methodology/ Method	Equipment/Tools and software (Open source software like QGIS is suggested)	Teaching Hours: 90 hrs
1. Geo-referencing	1.1 Geographic data preparation 1.2 Spatial referencing 1.3 Projection transformation	Desktop computer or laptop with GIS software	6 hrs
2. GIS Data (Spatial and Attribute) Preparation	2.1 Vector data creation / vectorization/capture from analog map, digital map or Google image 2.2 Data Editing 2.3 Data Integration 2.4 Data queries	Desktop computer or laptop with GIS software	12 hrs
3. Spatial Analysis in GIS	3.1 Geoprocessing 3.2 Neighborhood analysis (Proximity) 3.3 Network analysis 3.4 Overlay analysis (Point, Line, and Polygon) 3.5 Data interpolation and 3-D map preparation	Desktop computer or laptop with GIS software	15 hrs
4. Aerial Photo and Photogrammetry	4.1 Panoramic, oblique and vertical photo visualization and interpretation 4.2 Photo mosaic and Orthophoto	Desktop computer or laptop with image processing software	6 hrs

	preparation		
5. Image Data Format and Statistics	5.1 Familiarization with satellite image 5.2 Image display and band combination 5.3 Image subset and image mosaic 5.4 Spectral band combination and image enhancement 5.5 Visual image interpretation	Desktop computer or laptop with image processing software	16 hrs
6. Digital Image Processing (DIP)	6.1 Contrast enhancement 6.2 Spatial filtering 6.3 Image transformation 6.4 Image fusion	Desktop computer or laptop with image processing software	12 hrs
7. Image Classification	7.1 Unsupervised classification 7.2 Supervised classification 7.3 Object based image analysis	Desktop computer or laptop with image processing software	10 hrs
8. Global Positioning System	8.1 Satellite navigation 8.2 Position capture from the field 8.3 Transformation to georeferenced map	Handheld GPS device or Android mobile phone	5 hrs
9. Map Layout	9.1 Map design 9.2 Displaying spatial data 9.3 Displaying statistical data	Desktop computer or laptop with GIS software	8 hrs

Note: Dedicated GIS/RS laboratory with GIS/RS software and computer for the student-use is required for the practical work

Examination and Evaluation Scheme

Practical examination requires conducting as of the following model

- a) Written question: 25 %
- b) On the spot computer test: 50 %
- c) Practical workbook: 15 %
- d) Viva voce: 10 %

Total aggregate number determines the evaluation degree

References

Software manual/guide are available in the internet. Students can browse according to their use of the software.

Practical Work - II

Course Title: **Practical Work - II**

Course Cod: **MMS532**

Credit: 2 Hrs

Nature of Course: Practical (Compulsory)

Lecture: 90 Hrs

Course Overview

This MMS532 course is based on the practical and research part of theory course "MMS501: Mountain Tourism and Mountaineering: Concept and Practices". The course specifically focuses on equipment familiarization and types of wall/rock climbing, techniques of knots and rope works, pitons and camming devices, climbing movement, belaying, natural and artificial anchor setup, active rappelling technique with backup safety, trekking, and mountaineering.

Learning Objectives: (General and Specific)

The general objective of the course is to provide the comprehensive understanding of sports climbing and its associated disciplines to the students.

Specific Objectives

The course specifically aims at:

- gears and equipment familiarization and exploratory researches on the geological preferences of climbing rocks;
- enhancing climbing techniques, styles, movements with in-depth practical exercises on various climbing methodologies on multiple structures of wall and rocks.

Learning Outcomes

At the end of the course, students will be able to:

- understand, analyze, and applicate the learning of several gears and equipment of sports climbing;
- use the learned climbing styles, techniques, and movements in real sports climbing;
- garner practical idea of adventure sports (esp. sports climbing viz. wall and rock) in Nepal.

Practical Work/Research Work

Content	Methodology/ Method	Equipment/Tools	Field Training/ Practical Hours: 90 hrs
1. Equipment Familiarization <ul style="list-style-type: none"> - Type of climbing equipment - Type of technical equipment - Type of group equipment 	Introduction with gears and their capacity with practical	Personal gear, group gear, softshell, hard-shell, technical gear	5 hrs

- Type of rescue equipment	exercises		
2. Introduction to Rope Works and Knots Sheet bend, bowline knot, directional eight, double fisherman's knot, overhand knot, slip knot, clove hitch, Italian hitch, square knot, zeppelin bend knot, Guthrie hitch, rolling hitch, bowline stopper, thumb knot, figure of eight, bowline on a bite, claim hitch knot, butterfly knot, eight double loop, fisherman loop, provisional knot, snake knot, prussic knot, pile hitch, double thumb, tape-tie knot, rescue coil, butterfly coil	Practical and demonstration methods	Climbing rope, auxiliary cord, notebook, pen	10 hrs
3. Types of Climbing - Artificial wall climbing - Natural rock climbing - Lead climbing - Ice climbing - Tope rope climbing - Trad climbing - Bouldering - Aid climbing etc.	Practical demonstration of sport climbing center/natural rock climbing	Climbing rope, harness, figure of eight, carabiner of any belay device, quick draw, helmet, climbing shoes, physical and mental preparation, chalk powder, climbing partners	15 hrs
4. Anchor Setup - Type of anchors - Fixed and movable anchor - Capacity of anchor load, direction and angle - Natural and artificial anchors	Practical demonstration methods, rock craft	Tape sling, HMS carabineer, rope	5 hrs
5. Type of Pitons and Camlots - Types of pitons: Blade pitons, knife blade pitons,	Practical and demonstration rock craft	Rock pitons, all camming devices, rock hammer, rope	10 hrs

lost arrow pitons, angle pitons, bong pitons - Types of camlots - Process and setting of pitons			
6. Climbing Movement - Climbing movements foot placing - Body movement and side climbing - Movement of overhang climbing - Movement and applied handhold gripping	Practical and demonstration methods sports climbing center and natural rock climbing	Rock shoes, chalk bag, chalk powder, bolt, and anchor rope	10 hrs
7. Belaying - Roles of the belayer - Equipment used in belaying - Method of belay: top-rope belay, self-belay, hip belay, running belay	Practical demonstration with group in turn	Carabineer, harness, helmet, figure of eight or ATC, climbing rope, any belay device	15 hrs
8. Rappelling (Abseiling) Technique - Active rappelling (abseiling) - Passive rappelling - Classic abseiling - Protecting abseiling - Setting up back up safety - Measurement of rope distance with backup safety	Practical demonstration on ground and cliff	Helmet, harness, rock shoes, HMS carabineer, rope, all belay devices, rope tape selling	20 hrs

Evaluation Module

Practical/ Research evaluation requires conducting as of the following model:

- A. Preparatory work & gear arrangement: 10%
- B. Planning & teamwork: 20%
- C. Field work: 50%
- D. Field report & logbook: 10%
- E. Viva voice: 10%

Total aggregate number determines the evaluation degree.

Reference

Semester II Mountain Safety Protocols

Course Title: **Mountain Safety Protocols**

Course Cod: **MMS551**

Nature of Course: Theory (Compulsory)

Credit: 3 Hrs

Lecture: 45 Hrs

Course Overview

The course encompasses technical aspect of the emergency safety drills and protocols that are the necessity of mountaineering expeditions or explorations. It includes, mountaineering methodology, impact of global warming on safety measure, climbing rules regulation and safety security, mountain risks & hazards analysis, mountaineering risk analysis & management, adaptation in the face of increased mountain environmental risk, mountaineering planning development, accident procedure. With students being familiar with the safety protocols, Nepal could progress as the hub of safe mountaineering and adventure sports.

Learning Objectives: (General and Specific)

The general objective of the course is to enlighten academically and technically train the students on understanding and executing the mountain safety protocols and procedures.

The specific objectives of the course are:

- to enable students to learn and apply the preparations and setups for mountaineering expeditions;
- to aware the impacts of commercial mountain tourism and mountaineering on the Himalayas and mountains over the world;
- to enable students to comprehend the climbing rules and safety, based on both papers and practice;
- to allow students to perform in-depth researches on mountain disasters, accidents and risk mitigations;
- to help students become strategic human capital in understanding the safety aspect of mountaineering, working for the development of safe mountain tourism.

Learning Outcomes

At the course's culmination, students will be able to

- learn and apply the preparations and setups for mountaineering expeditions
- comprehend the climbing rules and safety, based on both papers and practice
- perform in-depth researches on mountain disasters, accidents and risk mitigations
- understand the safety aspect of mountaineering, working for the development of safe mountain tourism

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours 45 hrs
Unit 1: Mountaineering Methodology	1.1 Basics mountaineering knowledge <ul style="list-style-type: none"> - Preparation for ascent - Mountaineering - Communication with group - Rope & knots - Safety reasons - Leadership skills - Fitness and stamina - Group management - Safety measure - Route selection - Decision making - Orientation and navigation - Dictating crevasses & rescue 1.2 Gear and accessories <ul style="list-style-type: none"> - Technical gear - Nontechnical gear - Mountaineering accessories - Personal accessories - Choosing proper equipment - Rescue equipment - Group equipment - Rock climbing accessories 1.3 Belaying and rappelling <ul style="list-style-type: none"> - Belaying and anchor set up - Selection of belay spot - Rappelling/ abseiling methods - Running belay - Self-belay methods 	10 hrs
Unit 2: Impact of Global Warming on Safety Measure	2.1 Human activity's safety <ul style="list-style-type: none"> - Water vapor - Carbon dioxide - Nitrous oxide - Wither changing 	4 hrs
Unit 3: Climbing Rules Regulation and	3.1 Mountaineering Regulation Act 2059 BS 3.2 Tourism Act 2035 BS 3.3 Climbing rules for above 8000 m	6 hrs

Safety Security	<p>3.4 Climbing rules below 8000 m</p> <p>3.5 Insurance policies and systems</p> <p>3.6 Climbing safety measure policy</p>	
Unit 4: Mountain Risks & Hazards Analysis	<p>4.1. Risk assessment human factors</p> <ul style="list-style-type: none"> - Preparedness - Training - Technical knowledge & skill - Health issues - Physical stamina <p>4.2. Climatic and wither risk</p> <ul style="list-style-type: none"> - Changing weather and wind - Humidity temperature degrade - Precipitation visibility - Lightning thunder storm <p>4.3. Mountain hazards</p> <ul style="list-style-type: none"> - Snow avalanche - Terrain and steep slope - Landslides - Volcano <p>4.4. Wildlife & insect</p> <ul style="list-style-type: none"> - Remote & animal protector aria - National park and conservation aria <p>4.5. Lost person: Lost person behavior</p> <ul style="list-style-type: none"> - Search and rescue - Navigation skills - Lack of communication skills <p>4.6. Snow avalanches: Forecasting- Rescue</p> <ul style="list-style-type: none"> - Check weathers conditions - Wind speed and direction - Temperature increase and decrease - Check type of snow condition - Analysis the problems and cases - Apply the First AID - Transport victim to hospital 	10 hrs
Unit 5: Mountaineering Risk Analysis & Management	<p>5.1 Equipment failure</p> <ul style="list-style-type: none"> - Lack of mountaineering knowledge - Poor preparation and communication gap - Loss of physical stamina <p>5.2 Outdoors management</p>	6 hrs

	<ul style="list-style-type: none"> - Traveling alone - Clothing and equipment - Camping food and water - Traveling restricted area - Traveling without permeation - Traveling without planning - Terrain and slope navigation - Leave no trace - High Altitude pathology - Mountain formation and linked risks 	
Unit 6: Adaptation in the Face of Increased Mountain Environmental Risk	6.1 Mountain environment <ul style="list-style-type: none"> - Mountain geology - The cycle of snow - Air movement - Mountain weather 	3 hrs
Unit 7: Mountaineering Planning Development	7.1 Starting <ul style="list-style-type: none"> - In the field - Key places - Apply the plan 	3 hrs
Unit 8: Accident Procedure	8.1 Incident Action Plan <ul style="list-style-type: none"> - Take charge of the situation - Approach the patient safely - Perform emergency rescue and urgent first AID - Check for other injuries - Make the plan - Carry out the plan - Evacuation Plan 	3 hrs
Evaluation Scheme	<i>In-Semester</i> 40%	
	<i>End-Semester</i> 60%	
	<i>Total</i> 100%	

Text Books/Materials

Mountaineering: (The Essential Skills for Mountain Walkers and Climbers)/ / Alun Richardson

Mountain Risks: From Prediction to Management and Governance/

Editors: Van Asch, T., Corominas, J., Greiving, S., Malet, J.-P., Sterlacchini, S. (Eds.)

Climbing: Expedition Planning (Mountaineers Outdoor Expert)/ by Clyde Soles

Basic standard for Mountaineering/ In progress

Environmental Impact of Mountain Tourism

Course Title: **Environmental Impact of Mountain Tourism**

Course Cod: **MMS552**

Credit: 3 Hrs

Nature of Course: Theory Compulsory)

Lecture: 45 Hrs

Course Overview

Mountains are the landforms having high degree of spatial heterogeneity in topo-climatic variables. Mountains show the associated context of combination of biotic and abiotic factors and processes, and therefore are the reserves of huge amount of natural goods and services. In the present context of over-exploitation of resources and degradation of ecosystems across the regions, the mountain tourism has several socio-ecological and environmental implications. Thus, for the sustainable mountain tourism, understanding of environmental impact of mountain tourism is crucial.

Learning Objectives: (General and Specific)

The general objective of the course is to understand the environmental impact of mountain tourism, and the specific objectives are:

- to provide students with an understanding of the mountain environment and socio-ecological systems in mountains;
- to acquaint students with the knowledge about socio-economic and environmental implications of mountain tourism, and its sustainability;
- to capacitate skills of students on various tools and approaches for socio-ecological and tourism impacts in mountain areas.

Learning Outcomes

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

- familiarize with socio-ecological systems of mountains and their implications in mountain tourism;
- discuss different types of mountain tourism and their environmental implications, especially in the mountain protected areas;
- apply the techniques for assessment, monitoring, and management of mountain tourism.

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours
		45 hrs
Unit 1: Tourism and Environment	1.1 Nature based tourism and ecotourism: Introduction and principles	10 hrs
	1.2 Evolution of tourism and ecotourism in mountain areas	

	<p>1.3 Current situation and trends in mountain tourism; tourism flow analysis</p> <p>1.4 Negative impacts of tourism on mountain environment</p> <p>1.5 Economic values of ecotourism in mountains</p>	
Unit 2: Socio- Ecological Systems and Mountain Tourism Implications	<p>2.1 Tradition, culture, values in mountains, importance of socio-cultural aspects on tourism</p> <p>2.2 Livelihood options in mountains and community-based mountain tourism</p> <p>2.3 Human-nature interaction (rituals and resources); role of local people in tourism development</p> <p>2.4 Building resiliency in mountain communities and ecosystems</p> <p>2.5 Resource utilization and sustainability issues</p>	10 hrs
Unit 3: Tourism in Mountains	<p>3.1 Overview of mountain tourism</p> <p>3.2 Protected areas mechanism and management practices in Nepal</p> <p>3.3 Issues and potential constraints of tourism development in mountain areas</p> <p>3.4 Implication and sustainable future of mountain tourism</p> <p>3.5 Mutual benefits for tourism and mountain protected areas</p> <p>3.6 National and international legal frameworks related to tourism</p>	10 hrs
Unit 4: Assessment, Monitoring, and Management of Mountain Tourism	<p>4.1. Methods of assessing socio-ecological vulnerability of mountain tourism</p> <p>4.2. Assessing implication of climate change in mountain tourism</p> <p>4.3. Environmental assessments: Steps and processes of REA, IEE and EIA (screening, scoping, TOR, establishment of baseline conditions, impact identification and analysis, public participation, environmental monitoring and auditing, EA reporting and review)</p> <p>4.4. Assessing carrying capacity of mountain protected areas</p>	15 hrs
Evaluation Scheme	<i>In-Semester</i> 40%	
	<i>End-Semester</i> 60%	
	<i>Total</i> 100%	

Text Books

Ceballos-Lascuráin, H. (1996). *Tourism, ecotourism and protected areas*. IUCN, Gland. ISBN 2-8317-0124-4

- Gerrard, A.J. (1990). *Mountain Environments: An examination of the physical geography of mountains*. The MIT Press. ISBN: 9780262071284
- IUCN / Nepal, 'EIA Training Manual for Professionals and Managers', IUCN/Nepal.
- Richins, H. and Hull, J. (eds) (2016). *Mountain Tourism: Experiences, Communities, Environments and Sustainable Futures*. CABI. ISBN: 978-1780644608
- Uprety B.K. (2003). *Environmental Impact Assessment: Process and Practice*. Mrs. Uttara Uprety, Koteshwor, Kathmandu.

References (Reading materials required and references)

- Eagles, Paul F.J., Bowman, Margaret E., and Tao, Teresa Chang-Hung (2001). *Guidelines for Tourism in Parks and Protected Areas of East Asia*. IUCN, Gland, Switzerland and Cambridge, UK. ISBN: 2-8317-0579-7
- Geneletti, D. and Dawa, D. (2009). Environmental impact assessment of mountain tourism in developing regions: A study in Ladakh, Indian Himalaya. *Environmental Impact Assessment Review*, 29, 229-242. doi:10.1016/j.eiar.2009.01.003
- Glasson J., Therivel R. and Chadwick A. (2005). *Introduction to Environmental Impact Assessment*. Routledge-Taylor & Francis Group.
- Gurung, T.B. (1998). *The impact of tourism in the foothills of Nepal: A case study on income generation, occupational structure, agriculture protection and firewood consumption patterns along the Dhampus-Pokhara trekking route in Nepal*. MA Thesis, The University of Montana.
- Jangra, R. and Kaushik, S.P. (2021). Estimating Carrying Capacity in a High Mountainous Tourist Area: A Destination Conservation Strategy. In: R. B. Singh et al. (eds.), *Global Geographical Heritage, Geoparks and Geotourism*. Advances in Geographical and Environmental Sciences. Springer. https://doi.org/10.1007/978-981-15-4956-4_22
- Kennell, J. (2014). Carrying capacity, tourism. In: Jafari J., Xiao H. (eds) *Encyclopedia of Tourism*. Springer, Cham. https://doi.org/10.1007/978-3-319-01669-6_24-1
- MoPE (2017). *Synthesis of stocktaking report for National Adaptation Plan (NAP) formulation process in Nepal*. Ministry of Population and Environment, Kathmandu.
- Pandey, R.N., Chettri, P., Kunwar, R.R. and Ghimire, G (1995). *Case study on the effects of tourism on culture and the environment: Nepal; Chitwan-Suraha and Pokhara-Ghandruk*. UNESCO Principal Regional Office for Asia and the Pacific, Bangkok. <https://unesdoc.unesco.org/ark:/48223/pf0000122619>
- Stursa, J. (2002). *Impacts of Tourism Load on the Mountain Environment: A Case Study of the Krkonoše Mountains National Park - the Czech Republic*. Monitoring and Management of Visitor Flows in Recreational and Protected Areas. A. Arnberger, C. Brandenburg, A. Muhar (eds.) Conference Proceedings.

- Sunlu, U. (2003). Environmental impacts of tourism. In: Camarda D. (ed.), Grassini L. (ed.). *Local resources and global trades: Environments and agriculture in the Mediterranean region*. Bari: CIHEAM. <https://om.ciheam.org/om/pdf/a57/04001977.pdf>
- United Nations Environmental Program (UNEP) (2001). *Environmental Impacts of Tourism*. <https://www.gdrc.org/uem/eco-tour/envi/index.html>
- United Nations Environmental Program (UNEP) (2007). *A practical guide to managing the environmental and social impacts of mountain tour*. UNEP, Conservational International and Tour Operators' Initiative for Sustainable Tourism Development.
- Wathern P. (1990). *Environmental Impact Assessment: Theory and Practice*. RoutledgeTaylor & Francis Group.

Glacial Geomorphology

Course Title: **Glacial Geomorphology**

Course Cod: **MMS553**

Nature of Course: Theory (Compulsory)

Credit: 3 Hrs

Lecture: 45 Hrs

Course Overview

The course has been embedded from basics of general geomorphological processes to glacial landscape development in different 11-chapter units. Then, it has initiated from fundamental concepts of plate tectonics theory and formation of the mountains, including knowledge of Himalayan geology. The core contents about the glacial geomorphology are adequately kept with sufficient credit hours. Finally, the course has included a chapter in the subject of natural hazards including Glacial Lake Outburst Flood (GLOF).

Learning Objectives: (General and Specific)

The focus of this course is on geomorphological processes and landforms associated with glaciers. Especially the objectives are:

- understanding of geo-processes;
- to develop insight into glacial geoscience, glacial process and development of landforms;
- to develop skills on method of research.

Learning Outcomes

An outcome of the course expects sufficient knowledge on analyzing in geomorphological processes and glacial landforms, with special focus on glacial environments. Especially the course outcome expects:

- creating ability to discover knowledge, wanting to know more, and with long-term retention of this knowledge;
- training the ability to perceive relations between glacier and its process for the landform development;
- developing ability to apply learning knowledge to solve problems on the subject matter;
- developing critical evaluation with logical analytical skills;
- developing ability to transfer the knowledge to professional career.

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours 45 hrs
Unit 1: Introduction	1.1 Aim, importance and disciplines 1.2 Glacial geology 1.3 Geomorphology	4 hrs

	1.4 Concepts of geomorphological system 1.5 Geomorphic scale	
Unit 2: Geology of Himalayas	2.1 Theory of plate tectonics 2.2 Mountain buildings 2.3 Geology of Himalayas 2.4 Higher Himalayan rock types and recent geological issues, processes	6 hrs
Unit 3: Mass Movement	3.1 Mass movement significance 3.2 Mass movement classification 3.3 Mass movement and landform evolution with emphasis on glacial environment	3 hrs
Unit 4: Glacial System	4.1. Glacier motion, processes of accumulation and ablation 4.2. Periglacial environment 4.3. Glacial driving mechanism 4.4. The principles of basal thermal regime and patterns and rates of ice flow 4.5. Interaction between rocks, debris and glacial mass	4 hrs
Unit 5: The Process of Glacial Erosion	5.1 Glacial abrasion 5.2 Crushing and fracturing 5.3 Plucking 5.4 Meltwater erosion 5.5 Glacial quarrying 5.6 Estimating Rates of glacial erosion, 5.7 Erosion and debris transport 5.8 Patterns of glacial erosion	4 hrs
Unit 6: Landforms of Glacial Erosion	6.1 Microscale features 6.2 Mesoscale features 6.3 Macroscale 6.4 Development of erosional landforms	4 hrs
Unit 7: Processes of Glacial Transportation	7.1 Glacier sediment movement: - Supraglacial load - Englacial load - Subglacial load - Debris formation 7.2 Accumulation and transportation mechanism 7.3 Different types of moraine formation	2 hrs
Unit 8: Landform of Glacial Deposit	8.1 Ice-Marginal Moraines 8.2 Subglacial landforms formed by ice or sediment Flow 8.3 Glaciofluvial landforms	4 hrs

Unit 9: Surface Morphology	9.1. Surface Morphology: Kames, Kame terraces, Kame deltas, collapsed masses, Kettles, Kettle lake, Eskers, glacier sedimentation, glaciofluvial, glacio-lacustrine, glacio-marine, loess, outwash dunes, glaciation reconstruction of past and prediction of future glacier, permafrost, and snow behavior and processes	6 hrs
Unit 10: Glacial Process and Natural Hazards in the Hindu Kush Himalaya	10.1 Glacial lakes in the Hindu Kush-Himalaya 10.2 Early warning systems 10.3 Monitoring, and GLOF mitigation 10.4 Remote sensing and GLOF risk assessment	4 hrs
Unit 11: Glacial Lake Outburst Flood (GLOF):	11.1 Moraine-dammed lakes 11.2 Ice-dammed lakes 11.3 Estimating GLOF magnitudes 11.4 Distribution of Glacial lakes in Nepal Himalaya	4 hrs
Evaluation Scheme	<i>In-Semester</i> 40%	
	<i>End-Semester</i> 60%	
	<i>Total</i> 100%	

Text Books

Douglas Benn, David J. A. (2010) *Evans Glaciers and Glaciation*, 2nd edition, Hodder Education. UK.

Henry J. Vaux, Jr. et al. (2012) *Himalayan Glaciers Climate Change, Water Resources, and Water Security by Hydrology, Climate Change*, THE NATIONAL ACADEMIES PRESS Washington, D.C.

Matthew M. Bennett, Neil F. Glasser (2009) *Glacial Geology Ice Sheets and Landforms*. John Wiley & Sons Ltd

References Materials

Benn, D. & Evans, D. J. A. 1998. *Glaciers and Glaciation*. Arnold Press. 734 pages. Price: ~\$65. New edition January 2010.

Bryn Hubbard, Neil F. Glasser (2005) *Field Techniques in Glaciology and Glacial Geomorphology*, John Wiley & Sons Ltd.

Evans, D. & Benn, D. 2004. *A Practical Guide to the Study of Glacial Sediments*, Arnold Press, 266 pgs. (supplemental lab materials)

Hambrey, M. & Alean, J. 2004. *Glaciers*, 2nd ed. Cambridge, UK.

- Henry J. Vaux, Jr. et al. (2012) Himalayan Glaciers Climate Change, Water Resources, and Water Security by Hydrology, Climate Change, THE NATIONAL ACADEMIES PRESS Washington, D.C.
- Hooke, R.B. 2005. Principles of glacier mechanics, 2nd ed. Cambridge, UK.
- Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods: Monitoring and Early Warning Systems in the Hindu Kush-Himalayan Region – Nepal by Mool, P. K., S. P. and Bajracharya, S. R. ICIMOD and UNEP, 2001363p.
- Matthew M. Bennett, Neil F. Glasser (2009) Glacial Geology Ice Sheets and Landforms. John Wiley & Sons Ltd

Dynamics of Snow, Ice & Glacier

Course Title: **Dynamics of Snow, Ice & Glacier**

Course Cod: **MMS554**

Nature of Course: Theory (Compulsory)

Credit: 3 Hrs

Lecture: 45 Hrs

Course Overview

The course is designed to impart the students an overall theoretical knowledge on understanding, observation, and monitoring of the cryosphere (snow, ice and glaciers) and the interaction between weather/climate and the cryosphere, with a focus in the Himalayas. After completing the course (MMS554) the practical course (MMS632) student should be able to carry out cryospheric research in the Himalayas and understand qualitatively and quantitatively the interaction between snow, ice, glacier and climate.

Learning Objectives: (General and Specific)

This course provides concept and analytical skill on understanding, observation, and monitoring of the cryosphere (snow, ice, and glaciers).

Specific objectives:

- Provides an overview of the components of the cryosphere, its processes, and interactions with climate;
- Improving an understanding of current state of the cryosphere, its components, and how they are changing;
- Support in examining some of the recent observed changes occurring in the Himalayan cryosphere and evaluate the changes due to climate change;
- Provide analytical knowledge for observation and monitoring of the cryosphere by up-to-date-methods (tools and techniques) available for understanding our cryosphere;
- The practical exercise will support in analysis of the data from the field and write a scientific writing on cryosphere;
- This course can also include an off-campus field trip.

Learning Outcomes

- Students will gain theoretical knowledge on Himalayan cryosphere (snow, ice and glacier) and be familiar with the related literature published in national and international journals.

Course Content

Course and Sub-Units	Units	Title/headings/subheadings	Lecture hours
			45 hrs
Unit 1:	1.1	Components of cryosphere: Snow, glaciers, ice	5 hrs

<p>Introduction to Cryosphere</p>	<p>sheets, permafrost 1.2 Glacial and periglacial environments 1.3 Role of cryosphere 1.4 Snow and glacier hydrology 1.5 Glacial-interglacial cycles</p>	
<p>Unit 2: Snow and ice Processes</p>	<p>2.1 Formation and distribution of snow 2.2 Snow measurement techniques, snow water equivalent, snow melt estimation 2.3 Classification of deposited snow 2.4 Metamorphism process of deposited snow 2.5 Transformation of snow to ice in dry and wet conditions</p> <hr/> <p>2.6 Snow, Firm, and Ice 2.7 Variation of density with depth 2.8 Rate of snow crystal growth 2.9 Age of air bubbles and its disappearance 2.10 Structure of ice crystal 2.11 Deformation of a single crystal and polycrystalline ice</p>	<p>8 hrs</p>
<p>Unit 3: Glaciers</p>	<p>3.1 Types of glacier 3.2 Nepalese glaciers 3.3 Zones in a glacier 3.4 Equilibrium line and its importance 3.5 Climatic significance 3.6 Determining equilibrium line altitude 3.7 Reconstructing former equilibrium line altitudes</p>	<p>4 hrs</p>
<p>Unit 4: Heat (energy) Budget of a Snow Pack and Glacier Surface</p>	<p>4.6 Components of heat (energy) budget 4.7 Heat (energy) budget estimations and measurement in the field 4.8 Heat (energy) budget on snow, glacier ice and debris</p>	<p>6 hrs</p>
<p>Unit 5: Structure, Deformation of Ice and Ice Flow</p>	<p>5.9 Structure of the ice crystal 5.10 Deformation of a single ice crystal 5.11 Deformation of polycrystalline ice 5.12 Ice flow relations 5.13 Field measurement of flow parameters 5.14 Values of flow parameters 5.15 Flow of valley glaciers 5.16 Glacier surges</p>	<p>4 hrs</p>

Unit 6: Glacier Mass Balance	6.1 Definition and mass balance terms 6.2 Measurement of glacier mass balance; Direct measurement, Remote sensing methods, Hydrological methods, and Climatic calculations 6.3 Mass balance gradients 6.4 Annual mass balance cycles 6.5 Mass balance of ice sheet	6 hrs
Unit 7: Permafrost	7.1 Characteristics, types and geographic distribution 7.2 Mountain permafrost features 7.3 Roles of permafrost; changes and effects on hydrology, landscape, infrastructure	4 hrs
Unit 8: Glacial/ Mountain Hazards	8.1 Glacial erosion 8.2 Glacier landforms 8.3 Avalanches, rock fall, snow storms 8.4 Glacial lake and Glacial Lake Outburst Flood (GLOF) 8.5 Glacier melt and sea level rise	4 hrs
Unit 9: Tools and Techniques	9.1 Tools for cryospheric observation and monitoring 9.2 Remote sensing and in situ methods 9.3 Cryosphere monitoring satellites 9.4 Numerical weather forecasting	4 hrs
Evaluation Scheme	<i>In-Semester</i> <i>40%</i>	
	<i>End-Semester</i> <i>60%</i>	
	<i>Total</i> <i>100%</i>	

Text and Reference Books

- Alen, M. H. J. (1992), *Glaciers*, Cambridge University Press, Cambridge.
- Bennett, M.R., & Glasser N.F. (1996). *Glacial Geology; Ice Sheets and Landforms*. John Wiley and Sons Ltd., England.
- Bishop, M. P., Björnsson, H., Haeberli, W., Oerlemans, J., Shroder, J. F., & Tranter, M. (2011). *Encyclopedia of snow, ice and glaciers*. Springer Science & Business Media.
- Douglas Benn and J. A. E. David (2010), *Glaciers and Glaciation*, Dept. of Geography and Topo Science, University of Glasgow, UK.
- French, H. M., & Williams, P. (2007). *The periglacial environment* (Vol. 458). Chichester: John Wiley and Sons.
- McClung, D. & Schaerer, P. (2011). *The Avalanche Handbook*. The Mountaineers Books.
- Paterson, W. S. B. (1994), *The Physics of Glaciers*, Third Edition, Pergamon Press, Oxford, London, Edinburg.

Mountain Ecology & Bio-diversity

Course Title: **Mountain Ecology & Bio-diversity**

Course Cod: **MMS555**

Credit: 3 Hrs

Nature of Course: Theory (Compulsory)

Lecture: 45 Hrs

Course Overview

The course on mountain ecology and biodiversity encompasses fundamentals of mountain ecology, ecological issues, mountain resources and their linkages, biodiversity status, pattern, threats, conservation approach, protected area network, policies and legal measures for conservation. Considered as the hub of biodiversity with some significant concentrations and species richness, Nepal Himalaya stands as an enticing and fragile land of ecology and biodiversity. The course with an apt analysis and understanding of mountain ecology and biodiversity anticipates furnishing capable and environmentally conscious academicians and practitioners.

Learning Objectives: (General and Specific)

General Objectives: The course objectivizes describing the ecological characteristics of mountain ecosystems, and understanding and assessing biodiversity elements for sustainable conservation and management.

Specific Objectives: After completion of the course, graduates will be able to:

- impart knowledge on the mountain ecology and biodiversity, identify threats to mountain biodiversity and current efforts to manage, conserve biodiversity;
- enhance the ability to assess the mountain ecosystems issues;
- enhance knowledge on the impact of climate change in the mountain ecosystems and biodiversity; and
- understand the role of legal instruments to conservation of mountain ecosystems and biodiversity.

Learning Outcomes

- The graduates will have knowledge of mountain ecology and biodiversity, and can analyze/assess the mountain issues, drivers and threats to biodiversity, and will be able to develop plans and programs for nature /biodiversity conservation.

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours
Unit 1: Mountain Ecology	1.1 Concept of mountain ecology: Bioclimatic classification of Himalaya, ecological advantages of	10 hrs

	<p>Nepal Himalayas</p> <p>1.2 Ecological factors in mountain: Topographic, edaphic, climatic and biotic factors</p> <p>1.3 Mountain ecosystems: Forest, grassland, agro-ecosystem, wetland, Concept of ecotone, Tree line, Phenology, Vegetation succession and forest stratification</p> <p>1.4 Plants and animal adaptations</p> <p>1.5 Ecological issues: Natural hazards, Upstream-downstream linkage, Demographic change, Climate change, Food security</p>	
Unit 2: Mountain Biodiversity	<p>2.2. Definition, concept, levels: Genetic, species, ecosystem</p> <p>2.3. Biodiversity perspective: Alpha, beta and gamma diversity</p> <p>2.4. Value of biodiversity</p> <p>2.5. Status and pattern of biodiversity in Nepal (including agro-biodiversity)</p> <p>2.6. Biodiversity hotspots: Endemism, endangered biodiversity,</p> <p>2.7. Flagship species of mountain regions: Snow leopard, Red Panda, Yar-tsa-gunbu</p> <p>2.8. Limiting factors of wildlife distribution in mountains, survival strategy</p>	8 hrs
Unit 3: Ecosystem Services	<p>3.1 Introduction: concept, definition</p> <p>3.2 Ecosystem services: Provisioning, regulating, cultural and supporting services</p> <p>3.3 Mountain biodiversity and livelihood (Forests and Pasture land resources, NTFPs</p> <p>3.4 Valuation of ecosystem services</p> <p>3.5 Payment for ecosystem services</p> <p>3.6 Nature tourism</p>	7 hrs
Unit 4: Threats to Biodiversity	<p>4.1 Anthropological causes (land use and land cover changes, deforestation, environmental degradation, climate change, fire, grazing, poaching and illegal trade, infrastructure development, etc.)</p> <p>4.2 Impacts of climate change on biodiversity</p> <p>4.3 Biological invasion</p> <p>4.4 Genetic erosion of agro-biodiversity</p>	7 hrs

Unit 5: Biodiversity Conservation	5.1 <i>In situ</i> conservation: Landscape approach, protected area system 5.2 Important Plant Areas (IPAs) 5.3 Important Bird Areas (IBAs) 5.4 Biological corridors and connectivity 5.5 Ramsar sites 5.6 Traditional knowledge and people's participation 5.7 Organizations involved in biodiversity conservation 5.8 Red Data Book	7 hrs
Unit 6: Environment and Biodiversity Policies and Legal Measures	6.1 Environment Protection Act and Regulations (including emphasis on Environment impact assessment) 6.2 Important conventions related to biodiversity including CBD & CITES 6.3 International treaties and agreements 6.4 Biodiversity strategy, policies and legal instruments	6 hrs
Evaluation Scheme	<i>In-Semester</i> 40%	
	<i>End-Semester</i> 60%	
	Total 100%	

Text Books

- Chaudhary, R.P. (1998). *Biodiversity in Nepal - Status and Conservation*. S. Devi, Saharanpur, India & Tecpress Books, Bangkok, Thailand, 325 pages.
- Jha, P K, F P Neupane, M L Shrestha and I P Khanal. (Eds). 2013. *Environment and Natural Resources* (Nepalpedia Series No 1). Publ. Nepal Academy of Science and Technology (NAST) Kathmandu, 558 pages.
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- Maiti, P.R. and Maiti, P. 2011. *Biodiversity: Peril and Perceptions*. PHI Learning Pvt. Ltd., New Delhi, India.

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- Chalise M.K. (2013a). Wildlife Ecology and Policies of Nepal. A book for part of M.Sc. courses of Tribhuvan University. Nepal Biodiversity Research Society (NEBORS), Lalitpur. p. 67+7. Reprint 2014.
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- Huber, U.M., Bugmann, H.K. and Reasoner, M.A. (Eds.) (2005). Global change and mountain regions – An overview of current knowledge. Springer, 652p.
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- Jha, P K and I P Khanal. 2010. *Contemporary Research in Sagarmatha (Mt Everest) Region, Nepal: An Anthology*. (Eds) Publ Nepal Academy of Science and Technology (NAST), Kathmandu. 262 pp.
- Korner C (2003) *Alpine Plant Life: Functional Plant Ecology of High Mountain Ecosystems*. Springer
- Korner C, Spehm EM (Eds.) (2002) *Mountain Biodiversity: A Global Assessment*. The Parthenon Publishing Group (A CRC Press Company), New York, USA.
- Miehe, G., Pendry, C. and Chaudhary, R.P. (2015 Eds.). *Nepal – An introduction to the natural history, ecology and human environment in the Himalayas: A companion to the Flora of Nepal*. Royal Botanic Garden, Edinburgh, UK., 563 p. (Specially the chapter. Vegetation ecology).
- MOFSC.2002. *Forest and Vegetation Types of Nepal*. Department of Forest, Ministry of Forest and Soil Conservation, Nepal.
- MOFSC.2014. *Nepal Biodiversity Strategy and action plan 2014-2020*. Ministry of forest and soil Conservation, Nepal
- Mountain Biodiversity (<https://www.cbd.int/mountain/>)
- Pandey, R.K. (latest edition). *Himalayan Heights: Altitude Geography*. Ratna Pustak Bhandar, Kathmandu, Nepal.
- Price MF, Byers AC, Friend DA, Kohler T, Price LW (Eds.) (2013) *Mountain Geography: Physical and Human Dimensions*. University of California Press, California, USA [Chapters: 7 and 8].
- Singh JS, Singh SP and Gupta S R. 2017. *Ecology, Environment and Resource Conservation*. Chand and sons, new Delhi, India.
- Siwakoti M, P K Jha, S Rajbhandary and S K Rai (Eds) 2020. *Plant Diversity in Nepal*, Published by Botanical Society of Nepal.

- Wester, P., Mishra, A., Mukherji, A., and Shrestha, A.B. (eds) (2019). *The Hindu Kush Himalaya Assessment—Mountains, Climate Change, Sustainability and People* Springer Nature Switzerland AG, Cham.(Open access book)
- Wilson, E.O. (1992). *The Diversity of Life*. Harvard Belknap, Cambridge

Statistical Methods

Course Title: **Statistical Methods**

Course Cod: **MMS556**

Nature of Course: Theory (Compulsory)

Credit: 2 Hrs

Lecture: 30 hrs

Course Overview

The course focuses on an overview of descriptive statistical analysis, concept of probability and probability distributions, and conceptual details of inferential statistics such as estimation and testing of hypothesis using parametric tests and some non-parametric tests. The course also deals with the concepts and applications of correlation, simple, multiple linear regression models, including logistic regression model. Different time series analysis techniques are also discussed. Moreover, the course elucidates the appropriate use of statistical tools and problem specific interpretations of the statistical findings. Handling of statistical software for data management and data analysis is also discussed. The procedure of handling any one statistical software such as IBM, SPSS or STATA or R will be used for data analysis whichever convenient for the tutor.

Learning Objectives: (General and Specific)

General: After completion of this course, students will be able to apply suitable statistical method while conducting researches in their field of interest.

Specific: After carrying out of this course, students will be able to:

- explain the difference between descriptive and inferential statistics;
- classify and use different statistical measures appropriately as per the nature of data;
- understand the concept of probability, probability distribution and their computations;
- perform basic significant tests with the P value approach;
- perform linear, multiple and logistic regressions with reference to the data from the related field;
- analyze time series models and perform their exponential smoothing;
- perform statistical analysis appropriately using statistical software;
- provide problem specific interpretations of the statistical findings.

Learning Outcomes

At the successful completion of the course, students will be able to:

- understand the different measurement scales and able to perform appropriate descriptive as well as inferential statistical analysis;
- perform data management and statistical analysis using statistical software;
- prepare research report independently with evidence-based approach.

Course Content

Course Units	Title/headings/subheadings	Lecture hours 30 hrs
Unit 1: Overview of Statistical Concepts	1.1 Variables and type of variables 1.2 Data definition as per the scales of measurement 1.3 Concept of descriptive vs. inferential statistics 1.4 Appropriate use and misuse of descriptive measures 1.5 Exploratory data analysis (EDA) techniques 1.6 Z-score and its use in data analysis 1.7 Box and whisker plots, normal probability plots and their uses in data analysis 1.8 Concept of parameter, statistics, population and sample 1.9 Descriptive statistical analysis using statistical software and interpretations of the output	4 hrs
Unit 2: Probability and Probability Distributions	2.1 Different approaches of probability 2.2 Problems related to addition, multiplication laws of probability in relevant field 2.3 Dependent and independent events, conditional probabilities 2.4 Mathematical expectations 2.5 Concept of binomial, poisson distribution and their major characteristics 2.6 Normal distribution and its role in statistical science, computation of probabilities	3 hrs
Unit 3: Sampling and Sampling Distribution	3.1 An overview of different sampling techniques, sampling and non-sampling errors 3.2 Concept of sampling distribution and its use in statistics 3.3 Standard error of mean and proportion 3.4 Central limit theorem and its role in statistical science	3 hrs
Unit 4: Estimation and Testing of Hypothesis	4.1 Concept of estimation: point estimation and interval estimation 4.2 Interpretation of confidence interval estimation 4.3 Estimation of sample size 4.4 Basics of testing of hypothesis 4.5 One-sample hypothesis test: <ul style="list-style-type: none"> – Z and t tests for known and unknown population variance – The analogy between confidence intervals and two-tailed tests 	10 hrs

	<ul style="list-style-type: none"> – Test concerning a population proportion – The use of p-values in hypothesis testing <p>2.3 Two-sample hypothesis test:</p> <ul style="list-style-type: none"> – Test of significance of two means (independent sample) and its assumptions – Test of significance of two proportions – The paired t-test <p>2.4 Analysis of variance:</p> <ul style="list-style-type: none"> – One-way analysis of variance with post hoc test – Assumptions of one-way ANOVA <p>2.5 Non-parametric tests:</p> <ul style="list-style-type: none"> – Rationale of using non-parametric tests – Chi-square test for independence of attributes – Chi-square test for goodness of fit <p>2.6 Different statistical tests using statistical software and their problem specific interpretations</p>	
Unit 5: Statistical Modeling	<p>5.1 Pearson's correlation, assumptions, interpretations and its test of significance</p> <p>5.2 Spearman's rank correlation</p> <p>5.3 Concept of statistical modeling</p> <p>5.4 Linear regression model:</p> <ul style="list-style-type: none"> – Simple linear regression model and its interpretation – Overall fit of the model – Test of significance of regression coefficient – Confidence interval estimation of regression coefficient – Issue of extrapolation in regression – Coefficient of determination and its interpretation – Regression diagnostics – Multiple linear regression and its interpretation – Multiple linear regression along with dummy variable – Correlation and linear regression analysis using statistical software and the interpretations of the output <p>5.5 Concept of logistic regression model and its Interpretations</p> <ul style="list-style-type: none"> – Logistic regression analysis using statistical software <p>5.6 Criteria for model selection and the issue of model validation</p>	6 hrs
Unit 6:	6.1 Examples of time series data in mountain science	4 hrs

Time Series Analysis	6.2 Plot, trends and analysis of seasonal variations 6.3 Regression based time series models 6.4 The simple and single moving average method 4.5 Simple exponential smoothing 6.6 Prediction in trend models 6.7 Time series analysis using statistical software	
Evaluation Scheme	<i>In-Semester</i> <i>40%</i>	
	<i>End-Semester</i> <i>60%</i>	
	<i>Total</i> <i>100%</i>	

Note: Only the textbooks are not completely sufficient to cover the entire course and hence suggested to follow the reference books too.

References

- Anderson David R., Sweeney Dennis J and Williams Thomas A. (2002). Statistics for Business and Economics (8th Ed). India: Thomson South-Western.
Course (7th Ed.). India: Pearson.
- Daniel S. Wilks (2011). Statistical Methods in the Atmospheric Sciences (3rd Ed.) New York: Elsevier.
- Debbie L. Hahs-Vaughn & Richard G. Lomax (2020). An Introduction to Statistical Concepts (4th Ed). New York: CRC Press, Taylor and Francis Group.
- Draper N.R. and Smith H.(1998) Applied Regression Analysis(3rd Ed.). U.S.A: John Wiley & Sons
- Field Andy (2013). Discovering Statistics Using IBM SPSS Statistics. Sage Publication. Inc.
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- Williams, R.B.G. (1984). Introduction to Statistics for Geographers and Earth Scientists. London: Macmillan.

Practical Work - III

Course Title: **Practical Work - III**

Course Cod: **MMS581**

Credit: 2 Hrs

Nature of Course: Practical (Compulsory)

Lecture: 90 Hrs

Course Overview

This MMS581 course is based on the practical and research part of theory course "MMS502: Mountaineering in Nepal". The course incorporates a broad range of skills, activities, and parameters that constitute alpinism, from weather and terrain to forecasting snow levels and synchronization with the mountaineering ethics. The course equally has prioritized on sharpening technical mountaineering skills of the students.

Learning Objectives: (General and Specific)

General Objective

The course in general aims at enabling students to experience the Himalayan mountaineering as the world's most extreme sport on the foundation of theoretical skills as well as acquired technical sciences.

Specific Objectives

The specific objectives of the course are:

- to learn and applicate direct mountaineering skills as proper usage of bags, poles, navigation, map reading, briefing and others;
- to learn, understand and forecast the weather and hydro-meteorological phenomenon in the mountains;
- to perform peripheral mountaineering and team building exercises such as leadership, expedition financing, trip planning etc.

Learning Outcomes

At the end of the course, students shall be able to:

- applicate the constituting skills of trekking such as bag packing, hiking, walking with poles, weight balancing and so on;
- execute mountain research/mountaineering exercises on a designated high-altitude area with the standard gears, equipment and procedures;
- become a knowledgeable human capital in Himalayan mountaineering at the strength of skills as weather forecasting, hydro-meteorological analysis of the mountains and alpine zone/ climbing science professional.

Field Study/Practical/Research

Content	Methodology/	Equipment/Tool	Field Study/ Practical/
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	Method	s	Research Hours: 90 hrs
1. Trekking Pole and Bag Packing - Bag packing - Use of trekking pole - Basic navigation - Group leading & briefing - Pace setting & group controlling - Route selection & observation of alpine zone	Practical demonstrative methods	Pole, trekking bag, map compass	5 hrs
2. Mountaineering - Camping management - Mountain safety - Mountain weather - Navigation & route selection	Practical on mountain	All camping and mountaineering gears	15 hrs
3. Map Reading & Mountain Navigation - Introduction topographic map - Details of map - Counter line & feature recognize - Scale and measurement using compass with map - Natural hazard: Preparation of landslide hazard map using GIS technique	Practical demonstration	Map compass Arc GIS	10 hrs
4. Mountain Meteorology - Mountain weather - Summer weather system - Autumn weather system - Winter weather system - Spring weather system (wind, cloud, precipitation, thunder and lightning)	Practical analysis on field trip		10 hrs
5. Define Tree-line, Alpine Zone and Mountain Area	Practical analysis field trip	As per the field requirement and experts'	5 hrs

		suggestions	
6. Performing Leadership Skills and Camp Site Selection - Group control and management safety concern - Professional and personal appearance - Decision making and implementation	Practical and field base exercises	As required	20 hrs
7. Fixed Rope Setup & Moving Technique - Safety measures, - Fix anchor setup - Moving technique on fixed rope - Using ascenders	Practical demonstration	Static rope safety, ice screw, snow bar, ice axe, mountaineering boot, crampon, helmets	15 hrs
8. Self-Rescue - Non-technical self-rescue - Rope climbing - Mechanical self-rescue - Raising (hauling) with different pulley technique	Practical demonstration method on glacier	Rope, tape selling, Jumar, safety rope, auxiliary cord, HMS carabineer, harness, helmets	20 hrs

Evaluation Module

Practical/ Research evaluation requires conducting as of the following model:

- A. Preparatory work & gear arrangement: 10%
- B. Planning & teamwork: 20%
- C. Field work: 50%
- D. Field report & logbook: 10%
- E. Viva voice: 10%

Total aggregate number determines the evaluation degree.

Reference

Mountain Tourism Development: Policies & Plans

Course Title: **Mountain Tourism Development: Policies & Plans**

Course Cod: **MMS591**

Credit: 2 Hrs

Nature of Course: Theory (Elective)

Lecture: 30 Hrs

Course Overview

The course introduces the mountain tourism and its policies and plans to promote tourism in mountain areas. It briefly discusses the importance of mountains and its potentiality to develop tourism. The course focuses the concept of mountain tourism, policies related to mountain development, and institutions involved in implementing tourism related policies. The main purpose of the course is to develop a critical understanding of mountain tourism with reference to Nepal.

Learning Objectives: (General and Specific)

The course is expected to bring a change in students' behavior to care and improve mountain environment while designing and implementing a project in the mountains. Moreover, it makes students understand the importance of natural resources in mountain areas and their contribution to local and national development.

The specific objectives of the course are:

- Students become familiar with the mountain's natural resources & their values, and tourism policies and plans with reference to Nepal;
- Make change in students' behavior through their understanding of how mountain tourism contributes to local and national development;
- Develop students' skills in planning and managing tourism industry in mountain areas.

Learning Outcomes

By the end of the course students should be able to:

- Understand the concepts of mountain tourism from global to local perspective;
- Recognize the linkage between mountain People, communities and Mountain Tourism Development;
- Review major policies, plans and strategies of tourism sector and identify the gaps and constraints;
- Review the institutional structure for mountain tourism development and identify their roles/responsibilities and linkages;
- Evaluate the implemented programs and projects on Mountain tourism development in Nepal.

Course Content

Course and Sub-Units	Units	Title/headings/subheadings	Lecture hours 30 hrs
Unit 1: Concept of mountain and mountain tourism		1.1 Concept of mountain, mountain from global, regional, and local (Nepal) perspectives, mountain tourism 1.2 Characteristics of mountain resources 1.3 Mountain tourism Development - Theoretical perspective of tourism development - Conceptual framework for mountain tourism - Mountain tourism vs sustainable tourism - Mountaineering vs sustainable tourism - Mountain sports tourism 1.4 Significance of mountain tourism - Attraction of mountains - Adventure activities in mountain areas 1.5 Mountain and green economy - Mountains for a green economy and global sustainable development - Green farming - The green services – tourism 1.6 Link between mountain ecosystem and tourism 1.7 Local aspects of mountain tourism	8 hrs
Unit 2: Mountain People, communities and Mountain Tourism Development		2.1 Mountain people, communities and tourists - Partnership and collaboration in tourism - Sustainable principles for mountain communities 2.2 Challenge of mountain tourism - Ecological problems - Global and local ecological problems of mountain tourism 2.3 Impacts of mountain tourism - Economic - Scio-cultural - Physical environment: Construction, litter and waste pollution, deforestation	5 hrs
Unit 3: Policies, plans and sustainable mountain tourism development		3.1 Major policy, planning and strategies of tourism under different periodic plan 3.2 Mountain tourism development policies in Nepal: - Tourism Policy 2065 (2008) - Tourism Master Plan 2008 - Tourism vision 2020,	6 hrs

	<ul style="list-style-type: none"> - National Tourism Strategic Plan 2016-2025 and - Visit Nepal Year, 1998 - Destination Nepal year, 2002-2004 - Nepal Tourism Year, 2011 - Environmental protection regulations 2020 - National framework on sustainable development goal 2030 <p>3.3 Guidelines for sustainable tourism</p>	
<p>Unit 4: Institutional framework and their role in mountain tourism development</p>	<p>6.4 Intergovernmental organizations</p> <ul style="list-style-type: none"> - United Nations World Tourism Organization - World Travel and Tourism council - International Institute for Peace through Tourism - Organization for Economic Cooperation for Development - Pacific Asia Travel Association - World Heritage Alliance <p>6.5 National Organizations</p> <ul style="list-style-type: none"> - National Planning Commission - Ministry of Culture, Tourism, and Civil Aviation - Department of Tourism - Nepal tourism Board - Nepal Mountain Academy - Trekking Agencies' Association of Nepal - Nepal Mountaineering Association - Nepal Association of Rafting Agents - Nepal Association of Tour and Travel Agents - Hotel Association of Nepal - Department of National Park and Wildlife Conservation - National Trust for Nature Conservation <p>6.6 INGOs/NGOs/Grass-roots Organizations such as World Conservation Union, World Wildlife Funds, and International Center for Integrated Mountain Development (ICIMOD)</p>	6 hrs
<p>Unit 5: Programs and projects in Nepal on mountain tourism Development</p>	<p>5.1 Programs and projects in Nepal</p> <ul style="list-style-type: none"> - Annapurna Conservation Area Project (ACAP) - Ghalegaon – Sikles Ecotourism Project (GSEP) - Kanchenjunga Community Based Ecotourism Project (KCBEP) - Manaslu Nature Based Ecotourism Project (MNBEP) - Upper Mustang Biodiversity Conservation Project 	5 hrs

	(UMBCP) - Tourism for Rural Poverty Alleviation Program (TRPAP) 5.2 Protected areas and mountain tourism	
Evaluation Scheme	<i>In-Semester</i>	40%
	<i>End-Semester</i>	60%
	<i>Total</i>	100%

References Material

- Agarwal, M.K. & Upadhyay, R. P. (2006) *Tourism and Economic Development in Nepal*, Delhi: Northern Book Centre
- Agenda, M. (1999). *Mountains of the world: Tourism and sustainable mountain development*. Mountain Agenda
- Barsila, Shanker Raj (2008). *Mountain development policies and programs in Nepal: At a glance*. Kathmandu: Initiative for Social Transformation Nepal (IST Nepal)
- Cham; H. Richins and J. S. Hull (eds) (2016). *Mountain Tourism: Experiences, Communities, Environments and Sustainable Futures*, CAB International, USA
- Clare, A. Gunn, (2002) *Tourism planning: Basics, concepts, cases*. London: Routledge
- D. Buhalis and C. Costa (eds.) (2006). *Tourism Management Dynamics: Trend, management and Tools*, Elsevier, UK
- Debarbieux B, Oiry Varacca M, Rudaz G, Maselli D, Kohler T, Jurek M (eds.). 2014. *Tourism in Mountain Regions: Hopes, Fears and Realities*. Sustainable Mountain Development Series. Geneva, Switzerland: UNIGE, CDE, SDC, pp. 108
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- Mason, P. (2003). *Tourism Impacts, Planning and Management*, Oxford: Butterworth-Heinemann
- Nepal, S. K and Raymond, C. 2005. *Mountain tourism: Towards a conceptual framework*, *Tourism Geographies*, 7 (3): 313-333
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- R. Harris, T. Griffin and P. Williams (eds) (2002). *Sustainable Tourism: A Global Perspective*, Butterworth -Heinemann, MA; P. M. Godde, M. F. Price and F.
- S. L. Slocum and C. Kline (eds) (2017). *Linking Urban and Rural Tourism: Strategy and Sustainability*, CABI, USA
- Upadhyay, P. (2019). Tourism Policy of Nepal and Sustainable Mountain Tourism Development in Retrospect. *The Gaze: Journal of Tourism and Hospitality*, 10(1), 37-50. <https://doi.org/10.3126/gaze.v10i1.22776>.
- World Tourism Organization, 2018. *Sustainable Mountain Tourism: Opportunities for Local Communities*, UNWTO; Spain
- Veal, A. J. (2002). *Leisure and tourism policy and planning* Second Edition. Cambridge . CABI Publishing
- <https://www.tourism.gov.np> for Tourism Policies
- <https://www.npc.gov.np> for Periodic Plans.

Mountain People & Livelihood

Course Title: **Mountain People & Livelihood**

Course Cod: **MMS592**

Nature of Course: Theory (Elective)

Credit: 2 Hrs

Lecture: 30 Hrs

Course Overview

The course in 30-hour session enables students to gain knowledge with real case examples on natural and social environment of the high mountains, natural resources in which they sustain their livelihood, major stressors that they face, and their dynamic adaptation strategies. They will also be able to use community-based climate vulnerability and capacity assessment tool.

Learning Objectives: (General and Specific)

The aim of this course is to familiarize the students on mountain people, livelihood diversification, livelihood challenges, mountain and sustainable development.

Specific Objectives: The specific objectives the course upholds are:

- to describe natural and human environment of high mountains, dynamics of livelihood and trajectories, livelihood inequality and marginalization, and stressors of livelihood;
- to assess the NRM system and their dependency on livelihood in the mountain areas, mountain ecology/ecosystem and climate change;
- to learn and examine the livelihood strategies and adaptive measures followed by mountain populations for thriving in the harsh geo-climatic conditions in the highlands;
- to conduct research using different frameworks for livelihood vulnerability and capacity assessment in mountain areas;
- to learn the importance of mountains and mountain life for sustainable development.

Learning Outcomes

- By the end of the course students will be able to apply their knowledge to enhance and sustain the mountains environment, to improve the livelihood of mountain people, and give priority to mountain development to achieve sustainable development goal of the nation.

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours 30 hrs
Unit 1: Introduction to High Mountains and	1. Introduction to high mountainous environment of Nepal - Natural environment: Climate, topography, biodiversity, soil, natural resources availability	6 Hrs

<p>Mountain People</p>	<ul style="list-style-type: none"> - Human and social environment: Major caste/ethnic groups, culture/ tradition, gender roles, landholding, access to services and infrastructures, dimension of poverty and economy - with one or two example of Mustang, Solukhumbu, Karnali, Dolpo etc 2. Introduction of high mountain environment of Asia, Andes, and Ethiopian highlands including natural and human/social 3. Key socio-cultural and economic features common to communities living in the major mountainous regions of (i) Nepal and (ii) other regions in the world 	
<p>Unit 2: Mountain Life and Living</p>	<ul style="list-style-type: none"> 2.1 Dynamic livelihood and trajectories 2.2 Major sources of income: On-farm and off-farm 2.3 Agriculture and food system including agro-biodiversity 2.4 Pastoralism and pasture tenure 2.5 Forestland and rural household's dependency 2.6 Migration for livelihood/income and its impact on natural resources management and gender 2.7 Access to sectorial services and infrastructure: <ul style="list-style-type: none"> - Health - Education - Irrigation - Livestock - Tourism 	<p>6 hrs</p>
<p>Unit 3: Major Stressors of Mountain Livelihood and Framework for Vulnerability and Capacity Assessment</p>	<ul style="list-style-type: none"> 3.1 Accessibility, marginalization, services and infrastructure, land holding size, extreme climatic condition and natural hazards, migration, social conflict to access and benefit sharing of natural resources, climate change 3.2 Impact of climate/ global changes on different sectors: <ul style="list-style-type: none"> - Agriculture - Pastoralism - Water resources - Ecosystem services - Forestry - Trekking and tourism 	<p>6 hrs</p>

	3.3 Framework for community-based climate vulnerability and capacity assessment in mountain areas	
Unit 4: Mountain Livelihood and Adaptation Strategies (in Past 20 Years & Present)	<p>4.1. Social and cultural strategies: Marriage, family and monkhood, polyandry, monks/monastic path</p> <p>4.2. Income diversification through on-farm strategies:</p> <ul style="list-style-type: none"> - Agriculture/horticulture - Livestock herding - Transhumance - Niche products of mountain <p>4.3. Income diversification through off-farm:</p> <ul style="list-style-type: none"> - Trade and business - Civil and private services - Mountain climbing as the mountaineering porters, helpers or guides <p>4.4. Migration —Seasonal movement to capture economic utility and advantages:</p> <ul style="list-style-type: none"> - Highlands and lowlands - Winter population movements to nearby towns/cities and neighboring countries 	6 hrs
Unit 5: Mountain Life and Sustainable Development	<p>5.1 Mountains matter for sustainable development:</p> <ul style="list-style-type: none"> - Global biodiversity hotspots - Water and energy for mountain and downstream people - Largest ice reserves outside the polar region - Provides recreational opportunity to global population etc <p>5.2 Sustainable food production and security in the mountain</p> <p>5.3 Poverty, land care and sustainable livelihood in mountain regions</p> <p>5.4 Gender equality and sustainable development</p>	6 hrs
Evaluation Scheme	<i>In-Semester</i> 40%	
	<i>End-Semester</i> 60%	
	<i>Total</i> 100%	

References (Reading materials/ required and references)

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International Cooperation, Diplomacy & Mountains

Course Title: **International Cooperation, Diplomacy & Mountains**

Course Cod: **MMS593**

Credit: 2 Hrs

Nature of Course: Theory (Elective)

Lecture: 30 Hrs

Course overview

Bridging science with policies and indigenous practices are crucial for the sustainable development in the mountain regions. The mountains are not only remote with poor and disadvantaged people, but also the ecological, social, cultural, and spiritual hubs including the global biodiversity hotspots. However, there are some pertinent issues in the regions, for instance, livelihoods, equity, and social and environmental security under the context of climate change and globalizations. Thus, this course is developed to understand the essence of international cooperation through diplomatic means and develop ability to negotiate for the sustainability of mountains. It also facilitates research and knowledge sharing among the students, and tailors it to the local needs, and acquaint about how to bring local issues to the global stage through diplomatic channels. The course basically aims to develop the ability of students as good negotiators on mountain related issues. It will provide a platform for empowering the students where policy makers, diplomats, experts, planners, and practitioners can share their research, information, and innovations, ideas and perspectives towards the achievement sustainable development in the mountain regions. Thus, empowering of the students ultimately help to environmental sustainability and livelihoods improvement of the mountain and downstream population.

Learning Objectives: General and Specific objectives

The general objective of the course is to understand the essence of international cooperation for the sustainability of mountains through diplomatic means and negotiations.

Specific objectives

The specific objectives of this course are to:

- provide in-depth knowledge on theoretical and philosophical perspectives of international cooperation and diplomatic means for the sustainability of mountains;
- enable the students to learn about the evolution and current trends of ecological, economic and socio-cultural dimensions in the mountain regions;
- equip the students with a knowledge on the relevant linkages of Nepalese diplomacy and mountains;
- acquaint the students about the contemporary issues of mountains and their resolution through international cooperation and diplomatic means;

- empower students to acquire practical knowledge on policies, laws, institutions, and various means of diplomatic channels for the sustainability of mountains;
- develop ability to organize and hold national/international meetings/conferences, and diplomatic negotiations on sustainability issues of mountains.

Learning Outcomes

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

- identify and understand the important features of Nepalese diplomacy for the sustainability of mountains, people and trade (tourism);
- apply the diplomatic channels for the resolution of contemporary issues in the mountain regions;
- demonstrate knowledge through academic and policy researches for the environmental sustainability and livelihoods improvement of the people in mountain regions.

Course Content

Course Units and Sub-Units	Title/headings/subheadings	Lecture hours 30 hrs
Unit 1: Conceptual Understanding of International Cooperation, Diplomacy and Mountains	1.1 Introduction of international cooperation (IC) 1.2 Theories and philosophical perspectives of diplomacy 1.3 Mountains, IC and diplomacy at global, regional and national levels 1.4 Mountain diplomacy in the age of globalization 1.5 Significance of mountains beyond the political boundaries 1.6 Role of cooperation and diplomacy in relation with culture, education, and scientific research for the sustainable mountain development	6 hrs
Unit 2: Ecological, Economic, Social and Cultural Perspectives of Mountains	2.1 Dimensions of ecological, social and cultural history of mountains 2.2 Economy and livelihoods of mountain people 2.3 Settlements, ethnic relations, and multiculturalism 2.4 Transnational cultural linkages including livelihoods, migrations, religious, minorities, and language 2.5 Conflict and peace in mountain societies 2.6 Historic North-South cooperation with case studies of Buddhism, diplomacy, and trade	6 hrs

<p>Unit 3: Nepalese Diplomacy and Mountains</p>	<p>3.1 Historical national memory in diplomacy, international cooperation and mountains 3.2 Hegemony, national interest and Nepalese mountains 3.3 Nepalese mountains, and diplomatic relationships among the eight regional countries of the HKH (Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan) 3.4 Case studies from Nepal, Bhutan, Sikkim and Tibet 3.5 Indigenous knowledge, intellectual property, research, innovations and Nepalese mountains 3.6 Nepalese mountain diplomacy in the 21st century (e.g., case highlight of <i>Sagarmatha Sambaad</i>)</p>	<p>6 hrs</p>
<p>Unit 4: Contemporary Issues and Mountains Diplomacy</p>	<p>4.1. Debates, diplomacy, negotiations and multilateral process for addressing the challenges of mountains including case studies from Conferences of Parties (COP) 4.2. Hydro-diplomacy: Trans-boundary river systems, upstream-downstream linkages, and payment for the environmental services 4.3. Mountain as a source of economic instruments, technology, resources and livelihood opportunities (e.g., eco-tourism/mountain tourisms, trekking/mountaineering) 4.4. Concerns of mountain people (conflict resolution and peace building) 4.5. Role of NGOs/CBOs, and local level stakeholders for the sustainability of mountains 4.6. Sustainable mountain development (Rio to beyond) including the role of social movements</p>	<p>6 hrs</p>
<p>Unit 5: Mountains and Governance</p>	<p>5.1 International practices and negotiations for mountain sustainability 5.2 Strategic planning in mountain development / soft power in international cooperation 5.3 Track two diplomacy and mountains (non-state actors and lobbying in mountain affairs) 5.4 Major international institutions including UNFCCC and associated protocols/agreements, UNEP, SARCC, ICIMOD, IUCN, and WWF and their major responsibilities for the mountain sustainability 5.5 Nepalese foreign policy and mountains 5.6 Federalism, power conflicts and sustainability of Nepalese mountains</p>	<p>6 hrs</p>
<p>Evaluation</p>	<p><i>In-Semester</i> 40%</p>	

Scheme	<i>End-Semester</i>	60%
	<i>Total</i>	100%

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Practical Work/Research Work (If requires)

- Organize the national/international meetings/conferences; talk program, diplomatic negotiations, and seminar on mountains, governance and sustainable development.
- Organize a talk program on the role institutions related to mountain sustainability in Nepalese context e.g., role of National Planning Commission, Parliamentary Committees and Ministries.