TRIBHUVAN UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY

CURRICULUM ON
MASTER OF SCIENCE IN ENGINEERING GEOLOGY
(M.Sc. IN ENGINEERING GEOLOGY)

2073 BS (2016 AD)

CURRICULUM ON
MASTER OF SCIENCE IN ENGINEERING GEOLOGY

INTRODUCTION

Tribhuvan University is the oldest national university of Nepal which provides courses in a large number of disciplines. In view of the need of trained manpower in the field of Engineering Geology in the country, and having a wide scope internationally, the M. Sc. Engineering Geology Program has been established under TU. Presently engineering geology has a wide application in areas of engineering, primarily in investigation of geological conditions that may affect the design, construction, operation and maintenance of large scale engineering projects such as dams, tunnels, highways, water resources development, and natural hazard mitigation and environmental management. The aim of this course is to produce required manpower who can competently work in the field of Engineering Geology and capable of fulfilling the present demand of the industry and academia.

OBJECTIVES

The objectives of the present curriculum are to

- Produce high-level and competent manpower in the field of engineering geology as per the need of the country and international demand.
- Provide advanced and latest knowledge to students with sufficient geological, geotechnical and engineering base required for the practical application and research in engineering geology profession.
- Involve students in research activities to create broad research and analytical skills, and provide practical experience in the field of engineering geology. Create research facilities and environment for collaborations and cooperation with universities and institutions internationally.

ELIGIBILITY FOR ADMISSION

The candidates who have passed the B.Sc. course in Geology from the Tribhuvan University or the B.Sc. course in Geology from any other equivalent universities or institutions shall be considered eligible for admission to the M.Sc. course in Engineering Geology. They should have also attended the prescribed geological field training at the B.Sc. level.

Admission Criteria

The applicants will have to appear in an entrance examination of two hours' duration conduced by the Central Department of Geology. The applicant who fails to appear in the Entrance Examination or fails to obtain a minimum qualifying score will not be allowed admission. A merit list of the qualified applications will be prepared based on the percentage of marks in their B.Sc. Examination (20%) and marks obtained by them in the Entrance examination (80%). Admission of the students will be based strictly on the merit list and the enrolment capacity of the concerned institution.

Medium of Instruction: English

Duration of the program. Four semesters completed in two academic years. A student should complete the course within 5 years.

Hours of Instruction and Credit Calculation

Working days: 90 days per semester
Semester: 4
Total credits: 70
Full marks: 1750
Theory:
One credit = 15 lecture hours and 25 marks
One theory paper of one credit will have one hour of lecture per week.
Practical
One credit = 45 labwork hours and 25 marks
One practical paper of 1 credit will have 3 hours of practical per week.

Field work
One credit = 56 field work/lecture hours and 25 marks.
Field work will have 56 lectures/work hours per week.

Dissertation
The dissertation carries four credits. The student shall have to prepare a dissertation in the 4th semester. The dissertation will ordinarily include from 4 to 6 weeks of fieldwork.

Evaluation
Theory Paper
Forty percent (40%) marks as internal assessment and it is assessed by concerned teacher on the basis of assignments, attendance, seminar and internal examination. 60% mark is allocated for Final examination.

Practical:
The practical work is evaluated separately (100%).

Dissertation:
The dissertation will be submitted to the Scientific Committee of the Central Department of Geology. The dissertation will be examined by the Scientific Committee according to the rules and regulations of the Committee, the date for the defense of the dissertation will be fixed by the scientific committee of the central department of the Geology, Tribhuvan University.

Seminar
All students should present at least one paper allocated to him on the regular seminar of the Program and attain all seminars given by other students. The students are evaluated by assessing their presentation and attendance in seminars given by other candidates.

Grading
Students must pass all compulsory papers separately. The pass marks for both theory and practical is 50%. The performance of student shall be made on a four point scale ranging from 0 to 4 grades. A student must secure a minimum Grade Point Average (GPA) of 2.7 or Grade B minus (B) in each course. The absolute grading scale will be as follows:

Grade	CGPA	Percentage Equivalent	Performance Remarks
A	4.0	90 and above	Distinction
A^-	3.7	80-89.9	Very good
B^+	3.3	70-79.9	First Division
B	3	60-69.9	Second Division
B^-	2.7	50-59.9	Pass in Individual Subject
F	0	below 50	Fail

Certificate
The successful candidates who have passed all the examinations in theoretical and practical subjects, fieldwork, project works, seminar and dissertation work, will obtain a certificate of Master of Science in Engineering Geology from Tribhuvan University.

COURSE STRUCTURE

The first semester of master's degree program in Engineering Geology covers the following core study areas and appendant modules:

SEMESTER I

COURSE CODE	COURSE TITLE	CREDITS	MARKS (1 Cr. 25 MARKS)
EGE 511	Petrology and Sedimentology	2	50
EGE 512	Structural Geology and Applied Geomorphology	2	50
EGE 513	Geology of the Himalaya	2	50
EGE 514	Solid Mechanics	3	75
EGE 515	Fundamentals of Engineering Drawings	2	50
EGE 516	Applied Mathematics and Statistics	3	75
EGE 517	*Practical I:* Petrology and Sedimentology	1	25
EGE 518	*Practical II*: Fundamentals of Engineering Drawings	1	25
EGE 519	*Practical III*: Structural Geology	1	25
EGE 520	Field work (9 days)	1	25
	Total:- 14 Theory + 3 Practical + 1 Field work	**18**	**450**

Full Credit: 70 and Full Mark: 1750

SEMESTER I

SEMESTER: I *EGE 511*

Course Title: Petrology and Sedimentology Full Marks: 50
Course No.: EGE 511 Pass Marks: 25
Nature of the course: Theory
Credit 2 (30 hrs)

COURSE DESCRIPTION

This course aimed to introduce the concepts of igneous, metamorphic and sedimentary petrology and sedimentology. In petrology, it deals with the igneous, metamorphic and sedimentary rocks focusing on their origin, classification, and petrographic description. Sedimentology provides knowledge on sediment properties, sediment formation and erosion, sediment transport, and sedimentation and sediment characteristics.

OBJECTIVES

General Objective. To provide in-depth understanding of igneous, metamorphic and sedimentary rocks and their processes of formation and origin.

Specific Objective. To provide the students with knowledge and practical skills of

- Identifying composition, texture and structures of igneous, metamorphic and sedimentary rocks and classifying and describing them using modern methods of analysis,
- Recognizing, describing and classifying sediments, their properties and sedimentation processes.

COURSE CONTENTS

Part A: PETROLOGY (1 credit)

Igneous Petrology

Petrography and composition of magmatic rocks: Optical properties of rock-forming minerals in recognizing various minerals under the polarizing microscope. Classification of igneous rocks: Streikeisen's classification of igneous rocks; Mineral composition and fabrics of acidic rocks, intermediate rocks, basic rocks and ultra-basic rocks with emphasis to identification in the field. **2 hours**

Texture and structure of igneous rocks. Crystallinity, grain size, grain shape, texture of glassy or fine-grained rocks, flow textures, intergrowth textures, reaction texture, structures in volcanic rocks, structures in plutonic rocks and structures resulting from inclusions. **2 hours**

Metamorphic Petrology

Concept of metamorphism: Definition and factors of metamorphism, types of metamorphism. **1 hour**
Nature of metamorphism: Metamorphic record of original rock, types of metamorphic processes, metamorphic field relations, imposed fabric resulting from metamorphism, mineralogical composition, isograds and grades of metamorphism, metamorphic rocks of different grades, petrography of some metamorphic rocks of the Himalayas, metamorphic zones and facies. **3 hours**

Metamorphic textures and deformations: The textures of metamorphic rocks, Relationships between metamorphism and deformation. Petrofabric study. S-C fabrics in Interpretation of deformation history.
1 hour

Sedimentary petrology

Mineralogical composition, classification, textures, structures, origin and diagenesis of sedimentary rocks:

conglomerate, sandstone, mudrocks, limestone, and dolostone. **4 hours**

Sedimentary structures: Depositional structures, erosional structures, syn-sedimentary deformational structures and their significance in engineering geology. **1 hour**

Part B: SEDIMENTOLOGY (1 credit)

Types of sedimentary particles: Solid Breakdown products of older deposits: Inorganic terrigenous sediments and carbonaceous organic debris. Particles that are not solid breakdown products of older deposits: pyroclastic particles and authigenic particles. **1 hour**

Classification and Nomenclature of Sediments: Siliciclastic Sediments: Gravel-sand-clay mixture, Sand-silt-clay mixture and Carbonate Sediments. **1 hour**

Physical Properties of Sediments and water sediment mixture: Mass density and Specific weight of solid particles, Submerged specific weight of a particle, Specific Gravity; Grain size, grain size classification, fall diameter, nominal diameter, gradation coefficients, probability plots and various graphic measures of size distribution; shape factor, form, sphericity and roundness; sorting, packing, orientation of particles, porosity, void ratio, dry specific weight of mixture, dry specific mass of mixture, Sediment suspension: volumetric sediment concentration, specific weight of mixture, dynamic viscosity of Newtonian mixture, kinematic viscosity of Newtonian mixture. **2 hours**

Sediment formation and erosion: Physical and chemical weathering, Concept of Erosivity and erodibility: Mechanism of erosion by fluid. Soil erosion: surface erosion: interrill and rill erosion; channel erosion: gully erosion and river erosion; Gravitational erosion: Gravity Displacement Processes: Gravity shearing, debris avalanche, debris slide, debris flow, fluidized flow, grain flow, and turbidity flow. Quantifying gully erosion and river erosion, Sediment Delivery Ratio, sediment rating curves, Annandale's Erodibility Index Method. **2 hours**

Sediment transport: *Stream morpho-hydrologic parameters and Flow Velocity-Discharge Measurement***:** Stream planform parameters: Sinuosity, radius of curvature, meander length and width; Morpho-hydrologic parameters: width, cross-section, depth, maximum depth, flood prone width; Vertical Velocity Distribution, Velocity Profile Measurement, discharge measurement: Area-velocity method. **1 hour**

Resistance to Flow: State of flow, Effect of fluid viscosity: laminar flow and turbulent flow, Reynolds Number, Drag Coefficient, Effect of gravity: Froude Number. Chézy Equation, Manning Equation, and Darcy-Weisbach Equation. Hydraulic flow-resistance factors. Estimating Total Roughness using Cowan's Method. **1 hour**

Sediment loads: Modes of transport, Bedload transport, Incipient motion, Boundary conditions. Bed Shear or Tractive Force, Empirical equation, Shields Diagram, Hjulström Approach. Suspended load Transport: Sediment Concentration Profile, Total Sediment Load and Transport Capacity. **2 hours**

Sediment Deposition and sediment characteristics: *Lake or reservoir*: Settling velocity of mud and coarse grains, simplified equations for fall velocity. Flocculation. Subaqueous gravity displacement sedimentation: sedimentation from turbidity currents. *Alluvial fan:* Debris flow fan and stream flow fan. *Braided Rivers*: channel and bar deposits; *Meandering Rivers*: In-channel, bank and flood plain deposits; *Glacial environment*: glacial and periglacial deposits. **4 hours**

TEXTBOOKS

1. Best M. G. (1986): *Igneous and Metamorphic Petrology,* CBS Delhi, 639p.
2. Yardley B. W. D. (1990): *An Introduction to Metamorphic Petrology, ELBS, 248p.*
3. Tucker, M.E. (1981). *Sedimentary petrology: an Introduction. Geoscience Texts Vol.3. Blackwell Scientific publications.252p*

4. Tamrakar, N.K. (2011): *Practical Sedimentology. Bhrikuti Academic Publication, Kathmandu, 232p.*
5. Morris, G. L. and Fan, J., (2010), *Reservoir Sedimentation Handbook, McGraw-Hill, 805p.*
6. Sanders, J.E. (1978): *Principles of Sedimentology. . John Wiley and Sons, New York, 792p*.
7. Collinson, J.D. And Thompson, D.M. (1994): *Sedimentary structures, CBS, Delhi, 207p.*
8. Pettihohn, F.J. (1975). Sedimentary rocks. *Harper and Row, New Yo5rk, 628p.*
9. Richard C. Selley, (2000), *Applied Sedimentology, Second Edition, Academic Press, 543p.*

REFERENCE BOOKS

1. Phillpots, A. R. (1994): *Principles of Igneous and Metamorphic Petrology,* Prentice-Hall of India Pvt. Ltd., 498 p.
2. Phillpots, A. R. (2003): *Petrography of Igneous and Metamorphic Rocks,* Waveland Press, Inc., 178 p.
3. Paudel, L. P. (2011). *Study of Minerals and Rocks in Thin Sections*. GEOS, 102p.
4. Rai, S. M. (2011): *Study of Minerals and Rocks in Hand specimens*. Creative Work, Nepal, 152p.
5. Thorpe, R. S. and Brown, G. C. (1995): *The Field Description of Igneous Rocks,* John Weiley & Sons, 154 p.
6. Hutchinson (1974): *Laboratory Methods in Petrography,* John Wiley and Sons, New York, 527 p.
7. Winkler H. G. F. (1987): *Petrogenesis of Metamorphic Rocks.* 5th edition, Narosa Publishing House Delhi, 348 p.
8. Roy Lindholm, (1999), A practical approach to sedimentology. CBS Publishers & Distributors, Delhi, 176p.
9. Greensmith, J.T. (1978). Petrology of the sedimentary rocks. (sixth Edition). George Allen & UNWIN/Thomos Murby, London, boston, Sydney.

SEMESTER: I *EGE 512*

Course Title: Structural Geology and Applied Geomorphology Full Marks: 50
Course No.: EGE 512 Pass Marks: 25
Nature of the course: Theory
Credit 2 (30 hours)

PARTA: STRUCTURAL GEOLOGY

COURSE DESCRIPTION

Structural geology deals with the architecture of the earth's crust and its componential parts. The course also provides the skills and techniques of study, analysis, and interpretation of the geological structures and their development in space and time.

OBJECTIVES

General Objective. To give in-depth knowledge and understanding of the structure of the earth's crust and its various components.

Specific Objective. It aims to provide students with the basic concepts of deformation of rocks, and of the mechanisms and causes of deformation. Students will get in-depth knowledge and practical skills for the study, analysis, and interpretation of folds, faults, joints, foliation, and lineation, and the concepts of stress and strain. It will familiarize students how to describe and record geological structures in the field; and enable students how to evaluate, analyze and interpret structural data.

COURSE CONTENTS

Introduction. Concept, approach, and scope of structural geology. Primary and secondary structures. Primary sedimentary structures and their significance in structural geology. Structure of igneous rocks.
1 hour

Introduction to stereographic projections. Concept of stereographic projection, plotting a line and a plane, determination of the rake of a line, true dip and apparent dip problems, determining the Intersection of two planes. Determination of an intersection lineation, bisecting the angle between two planes. Rotation of a line and a plane about a vertical and a horizontal axis. Graphical treatment of the fabric data. Plotting and analysis of various structural elements. Uses and limitation of pi and beta diagrams. **1 hour**

Kinematic analysis. *Deformation,* definition, components of deformation, homogeneous and inhomogeneous deformation. **1 hour**

Strain. *Definitions.* Displacement vectors, Homogeneous and inhomogeneous deformations. One dimensional strain, strain in two dimensions, three dimensional strain, calculation of finite strain in two dimensions, strain ellipse and strain ellipsoid, angular shear and shear strain, Finite strain ellipse, strain equations, the finite strain ellipsoid and plain strain, coaxial and non-coaxial strain, Lagrangian and Eulerian specifications. Homogeneous deformation of straight line. Circle and ellipse (theory), progressive deformation, types of homogeneous strain ellipsoids and effect of volume change on deformation. Determination of finite strains from originally spherical and ellipsoidal markers. Behaviour of rocks with respect to stress and strain.
2 hours

Stress. *Definition.* Magnitude and units, Stress on a point. Stress on a plane. Normal stress and shear stress, stress components, stress tensor, Stress ellipse and stress ellipsoid, principal planes of stress and axial cross section, stress equations, . Mohr stress diagrams, relations between stress and strain. Rheology, elastic, plastic and viscous models of rock behaviour, stress in two and three dimensions. **2 hours**

Deformation mechanism and microstructures. Crystalline structures and strength of solids, deformation mechanism. **1 hour**

Folds. *Basic definitions*. Geometric analysis of folds, describing shape and size of folded surfaces (parameters of defining single fold surface), fold classification based on changes in layer thickness, classification based on dip isogon, kinematic analysis of folding, mechanics of buckling, Small-scale structures in folds and their interpretation, kink folding, Distribution of strain in folds, superposed folding. **1 hour**

Cleavage and foliations. Cleavage: Definitions*.* Geometric relationship of cleavage to folding and shearing, types of cleavages microscopic properties of cleavage, secondary tectonic cleavage (crenulation cleavage). Foliation**:** Definition*.* Primary and secondary foliation, metamorphic foliation, foliations in mylonitic rocks, orientation of foliation within strain ellipsoid. **1 hour**

Lineations. *Definition.* Types of lineation, types of linear structures, their relation with respect to strain ellipsoid. Significance of lineation in tectonic history, Relationship between planner and linear elements, lineations and kinematics. **1 hour**

Joints*: Definition*. Joints and shear fractures, characteristics of individual joint surfaces, propagation of individual fracture surfaces, classification and significance. **1 hour**

Faults. Fault terminology, physical characters of faults, fault rocks, naming of faults, displacement, slip and separation, classification based on slip and separation, thrusts, Normal, and strike slip faults, their classification and characters. Mechanism of faulting with reference to stress and strain ellipsoids, the birth and growth of faults. **1 hour**

Shear zones and mylonites. *Definition*. Classification and geometry of different types of shear zones. Brittle and plastic (ductile) shear zones, mylonites and kinematic indicators, Strain variations within shear zone. **1 hour**

Principles of Tectonics. Orogeny and epeirogeny. Thrusts and nappes. Schuppen and duplex. Geosynclines and continental margins. Continental drift. Introduction to plate tectonics. Sea floor spreading. Mid-oceanic ridges. Palaeomagnetism. Seismic zones. Transform faults and triple junctions. Island arcs. Causes of orogeny and global tectonics. Orogenic belts with special references to the Himalaya. **1 hour**

PART B: APPLIED GEOMORPHOLOGY

COURSE DESCRIPTION

The course on geomorphology provides the students with the understanding of the earth's surface features (i.e., landscape) in relation to the external and internal processes. It also studies the processes responsible for the change of the earth's landscape.

OBJECTIVES

General Objective. To give in-depth knowledge and understanding of the earth's landscape.

Specific Objective. To provide the students with in-depth knowledge and practical skills of

- Landforms and their classification,
- Factors affecting the formation of and changes in landforms, and
- Processes undergoing in the earth's crust, at the surface, in the hydrosphere, and atmosphere leading to the modifications of the landforms.

COURSE CONTENTS

Approach and Morphological evolutionary system: Fundamental concept of geomorphology, geomorphological system: outline of geomorphic process, geomorphic scale. The cycle of erosion, interruptions of the cycle of erosion, denudation chronology, criticisms of the cycle and alternative models, strategies for inferring landform evolution, new evolutionary concepts. **2 hours**

Igneous activity and landforms: Igneous activity in space and time, intrusive and extrusive constructional landforms, igneous activity in tectonic region. **1 hour**

Tectonic and Structural landforms: Horizontal and domed structures: types of domal structure, topographic expression, Homoclinal structures, folded, faulted: horst, grabens and related form, thrust control landform, diastrophism, diastrophism and erosion. **1 hour**

Weathering and soil: Geomorphic Significance of weathering, Formation of soil: description of major soil group, soil profile, landform evolution. Karst terrain: Surface landforms of karst, underground features of karst, types of karst terrain. **1 hour**

Mountain Environment and hillslopes: Evolution and classification of hill slopes, origin of hill slopes, hill slope erosion. Large scale landslides, flash flood, landslide dam and GLOF resulting landforms. **2 hours**

Fluvial process and landform: Braided and meandering system, sediments transport, hydrology, river morphology, rivers and valley morphology, Fluvial depositional landforms: Alluvial fans, valley fill, deltas. **1 hour**

Drainage basins: The basin geomorphic unit, morphometric analysis, morphometric control, drainage basin evolution, drainage basin response. **1 hour**

Aeolian processes and landforms: Aeolian environments, aeolian sand movement, wind abrasion, aeolian bedforms, cold and hot desert, coastal sand dunes, loess, snow drifting. **1 hour**

Glacier process and landform: Types of glaciers, glacier ice, glacier motion (flow), rock debris in glaciers, processes affecting debris at the glacier sole, erosion by glaciers, deposition by glaciers, landforms of glacial deposition, glacier melt water subsystem. Geomorphological effects of former glacier expansion. **1 hour**

Application of geomorphology: Application of geomorphology in hydrology, hydrogeology, engineering projects and in the urbanization. **1 hour**

Climatic geomorphology: Climate influence upon geomorphic process, humid tropical landforms, tropical wet-dry landforms, arid and semi-arid landforms, cold region landforms, the geomorphic effects of climatic change **1 hour**

Paleogeomorphology: Introduction, relict, buried, exhumed land form **1 hour**

Geoinformatics in Geomorphology: Remote Sensing and GIS in Tectonic geomorphic studies, Groundwater evaluation and delineating fractured aquifer zone in hilly terrain. **1 hour**

TEXTBOOKS

1. Richard John Huggett, 2007. Fundamentals of geomorphology, Second Edition. ISBN 0-203-94711-8
2. Burbank, D. W. and Anderson, R. S. (2007). Tectonic Geomorphology, *Blackwell Science.*
3. Fossen, H, (2010). Structural Geology. *Cambridge University Press. 463p.*
4. Davis G.H. and Reynolds, S.J. (1996). Structural Geology, Rocks and Regions (Second Edition). *John Wiley and Sons, INC.776 p.*
5. Hobbs, B. E., Means, W. D., and Williams, P. F. (1976). An Outline of Structural Geology. *John Wiley and Sons, 571 p.*

REFERENCE BOOKS

1. McClay, K. R. (1987). The Mapping of Geological Structures*, John Wiley and Sons Inc., 161 p.*
2. Ragan, D. M. (1985). Structural Geology, An Introduction to Geometrical Techniques, 3rd edition, *John Wiley and Sons Inc., 393 p.*
3. Chorley, R., Schumm, S.A., and Sugden, D.E. (1984). Geomorphology, *Methuen, 605p.*

4. Thornbury, D. W. (2000). Principles of Geomorphology, *New age International (P) Limited, Publishers, India. 594 p*
5. Marshak and Mitra. Basic methods of structural geology
6. Suppe J. (1985). Principles of Structural Geology. Prentice-Hall, Englewood Cliffs, New Jersey, 537p.
7. P. G. Fookes, E. M. Lee and G. Milligan. Geomorphology for Engineers. Whittles Publishing, CRC Press-Taylor & Francis Group. ISBN 978-1870325-03-5
8. Douglas W. Burbank and Robert S. Anderson. Tectonic Geomorphology. Blackwell Science. ISBN 978-0-632-04386-6
9. Siddan Anbazhagan, S. K. Subramanian and Xiaojun Yang. Geoinformatics in Applied Geomorphology. CRC Press- Taylor & Francis Group, 2011. ISBN 13: 978-1-4398-3049-9 (eBook)

SEMESTER: I *EGE 513*

Course Title: Geology of the Himalaya Full Marks: 50
Course No.: EGE 513 Pass Marks: 25
Nature of the Course: Theory
Credit: 2 (30 hrs)

COURSE DESCRIPTION

Himalayan geology covers the stratigraphic, tectonic, structural, magmatic, metamorphic and sedimentary geological aspects of the Himalaya.

OBJECTIVES

General Objectives. To give in-depth knowledge and understanding of the Himalayan geology and associated engineering geological problems.

Specific Objectives. To provide the students in-depth knowledge of

- various stratigraphic sub-divisions of the Himalaya,
- tectonic and structural set up of the Himalaya and its relation with the adjacent regions,
- comparison and correlation of various rock units,
- evolutionary history of the Himalaya,
- Engineering geological problems in the Himalaya.

COURSE CONTENTS

Broader framework. Relation of the Himalaya with other mountain chains of the region. Geology of the Peninsular India with special reference to Delhis, Vindhiyans and Gondwanas. **1 hours**

Major sub-divisions of the Himalaya. Geomorphic sub-divisions, tectonic sub-divisions. Brief account of the Punjab, Kumaun, Skkim and Bhutan Himalayas. **1 hour**

Stratigraphic classification in Nepal and adjacent countries. Precambrian successions of Higher and Lesser Himalayas, Paleozoic and Mesozoic successions of Tethys and Lesser Himalayas, Tertiary successions of Lesser and Sub-Himalayan zones. Quaternary successions of 'intermountain basins of Lesser and Higher Himalayas. Correlation of reference sections from Nepal and adjacent countries. Correlation of strartigraphic units of different parts of Nepal with type sections. Isotopic composition and detrital zircon ages of rocks of Nepal Himalaya. **12 hours**

Major Himalayan structures. Indus–Tsangpo Suture zone, Himalayan syntaxes, Tethyan Himalayan fold-and-thrust belt, Great counter thrust and north-Himalayan antiform, South Tibetan Detachment System (STDS) and other major extensional faults, Main Central Thrust (MCT), southward extension of the MCT (Lesser Himalayan nappes), relationship between MCT-I and MCT-II. Age and slip on the STDS and MCT. Out-of-sequence thrusts and uplifts of the Himalaya. Exhumation history of the Himalaya: Exhumation and foreland sedimentation in the Himalayas. Sedimentation in the foreland basin. **4 hours**

Metamorphism. Metamorphism in the Higher Himalaya and the MCT zone, low-grade metamorphism in the Lesser and Tethys Himalayas. Inverted metamorphism and its orign. Thermobarometric and geochronological data. Models for Himalayan inverted metamorphism: Kinematic models, thermal models, coupled thermal and mechanical models. **3 hours**

Magmatic rocks. Precambrian mafic rocks, Permian basalts, Precambrian granitoids, Early Palaeozoic granites. Tertiary granites, Geochemical and isotopic characteristics, geochronological data, petrogenesis and tectonic significance of magmatic rocks. Models for Cenozoic Himalayan anatexis. **3 hours**

Seismotectonics. Seismotectonics of the Himalaya, seismicity in the Nepal Himalaya, historic earthquakes, recent microseismicity, active faults and neotectonic activity, seismic hazard scenario in the Himalayas.

2 hours

Models of evolution of the Himalaya. The original configuration of the Himalaya prior to Cenozoic deformation: single passive continental margin model, separate basin model, accreted terrene model, carboniferous-extension model. Kinematic models for emplacement of the Higher Himalayan crystalline: Wedge extrusion and channel flow, continental subduction, MCT reactivation from Palaeozoic suture, models for the overall evolution of the Himalaya. **2 hours**

Engineering Geological characteristics of different tectonic zones of the Himalaya that affects the engineering geological behaviour of rocks and slopes in the Himalaya. **2 hours**

TEXTBOOKS

1. Valdiya (2010). Making Of India - Geodynamic Evolution. *MacMillan, India*
2. Journal of Asian Earth Sciences, Special Issue. Geology of the Nepal Himalaya: Recent Advances. , (1999), *Vol 17. Editors: P Le Fort and B.N. Upreti*
3. Valdiya, K. S. (1998). Dynamic Himalaya*, Universities Press, New Delhi.*
4. Valdiya, K. S. (1994). Aspects of Tectonic focus on South Central Asia, *Tata McGrawHill.*
5. Gansser, A. (1964). Geology of Himalayas, *John Wiley and Sons Inc.*

REFERENCE BOOKS

1. Yin, A. and Harrison, T. M. (eds.) (1996). The Tectonic Evolution of Asia, *Cambridge University Press.*
2. *Journal of Asian Earthsciences vol 19, Special Issue.*
3. Shakleton, R. M.., Dewey, J. F. and Windley, B. F. (eds.) (1988). Tectonic evolution and Himalaya and Tibet, *Cambridge University Press.*
4. Valdiya, K. S. (1980). Geology of the Kumaon Lesser Himalaya, *Wadia Institute of Himalayan Geology.*
5. Research articles in various issues of the Journal of Nepal Geological Society, *Bulletin of the Department of Geology, TU and international earth science journals.*
6. Mascle, G., Pêcher, A., Guillot, S., Rai, S. M. and Gajurel, A. P. (2012). The Himalaya-Tibet Collision. Nepal Geological Society, *Nepal, Société Géologique de France and VUIBERT, France.*

SEMESTER: I *EGE 514*

Course Title: Solid Mechanics Full Marks: 75
Course No.: EGE 514 Pass Marks: 37.5
Nature of the Course: Theory
Credit: 3 (45 hrs)

COURSE DESCRIPTION

The students will learn about Partial differential equations and integral equation, Fourier integral, theory of stress and strain. Theory of elasticity and viscosity.

OBJECTIVES

General Objectives. Learn the principles of deformation mechanism and mechanical properties materials.

Specific Objectives. The students will be have the basic knowledge of Stress and strain, principles of mechanics, deformation mechanism, energy and work, elasticity and viscosity of materials.

COURSE CONTENTS

Statics of Rigid Bodies: Statics of Rigid Bodies – Mechanics, Rigid and Deformable bodies, Equations of Static and Dynamic Equilibrium, Free-Body Diagrams. The Continuum – Classical definition and Material Continuum, The Concept of Stress in the Definition of Material Continuum. Vectors and Tensors, Vector Equations, Indicial Notation, Summation Convention and Differentiation, Matrices and Determinants, Partial differential Equations and Integral Equations, Fourier Integral, Functional Approximations. **4 hours**

Stress and Strain: Stresses: General Concept of Stress, Surface and Contact Stress, Internal Stress, Body Forces, Method of Sections, Normal and Shear Stresses, General State of Stress at a Point, Stress Tensor, Partial Differential Equations of Equilibrium, Stresses Acting on Arbitrary Planes, Transformation of Stress, Principal Stresses and Directions, Stress Invariants, Plane Stress, Octahedral Stress, Mean and Deviator Stresses.
Strains: Definition of Strain, displacement Field, Strain Displacement Relations, Strain Components, Strain Compatibility, Transformation Equations for Strain in Three Dimensions, Plane Strain, Properties of Strain.
8 hours

Linear Elasticity: Hooke's Law, Stress-Strain Relationship for Mild-Steel; Linear Elastic, Non-linear Elastic and Inelastic or Plastic Material; Elastic Constants and their Relations; Isotropic and Anisotropic Materials; Generalized Hooke's Law; Constitutive Relations for General Anisotropic and Isotropic Materials in Three Dimensions; Plane Stress and Plane Strain Problems; Axisymmetric Solids with Constitutive Relations. Torsion and Torsion formula; Thin-Walled Pressure vessel Theory; Simple beam Theory – Flexure Formula and Deflection of Simple Beams; Elastic Buckling; Euler's Formula for Buckling of Columns. **10 hours**

Failure Criteria: Failure of Elastic Material; Concept of Yield Criteria and Yield Surface for Isotropic Ductile materials, Maximum Normal Stress Theory for Brittle Fracture; Comparison of the Theories. **4 hours**

Energy and Virtual Work: Energy in Deforming Materials, Elastic Strain Energy and Complementary Energy, Strain Energy Potentials, Virtual Work Principle, The Principle of Minimum Potential Energy. **6 hours**

Viscoelasticity: The Response of Viscoelastic Materials, Models of Linear Viscoelastic Bodies, Examples and Applications of Viscoelastic Materials, Rheological Models, The Hereditary Integral, Linear Viscoelasticity and the Laplace Transform, Oscillatory Stress, Dynamic Loading and Vibrations, Temperature Dependent Viscoelastic Materials. **8 hours**

Plastic Limit Analysis: Introduction, Plastic limit analysis of Beams, Continous Beams and frames. **5 hours**

TEXT BOOK

Irving H. Shames, James M. Pitarresi (1999), Introduction to Solid Mechanics (3rd Edition).

REFERENCE BOOK

Edor P Popov and Toader A Balan, Engineering Mechanics of Solids (Second Edition).

Y. C. Fung (1994), A First Course in Continuum Mechanics (3rd edition).

SEMESTER: I *EGE 515*

Course Title: Fundamentals of Engineering Drawings Full Marks: 50
Course No.: EGE 515 Pass Marks: 25
Nature of the Course: Theory
Credit: 2 (30 hrs)

COURSE DESCRIPTION

The students will learn the Instrumental and free hand drawing techniques, applied geometry, theory of projection drawings, multiview and sectional view drawings.

OBJECTIVES

General Objectives. The students will have the knowledge and skill and knowledge on basic engineering drawings.

Specific Objectives. The main objectives of this course is to provide the students the skills of instrument and free hand lettering and drawing, learn the multiview and sectional drawing and develop the capacity to understand various types of civil engineering drawings and designs.

COURSE CONTENTS

Engineering Drawings, Equipment, and Materials: Fundamental concept on necessity of engineering drawing and equipment details: Uniformity in Engineering drawing, instrument used to prepare engineering drawing and their uses, drawing sheets preparation, use of standards and commonly accepted practices in engineering drawing. **1 hour**

Freehand Technical Lettering: Difference between freehand and technical lettering, uses of technical lettering, essential features of technical lettering such as legibility, uniformity, ease, rapidity, and suitability. Concept of lettering strokes, letter proportions, use of pencils and pens, uniformity and appearance of letters, inclined and vertical letters and numerals, upper and lower cases, standard English lettering forms. **1 hour**

Dimensioning: Importance of dimensioning in Engineering drawing, elements of dimensioning, aligned and unidirectional system, standard rules to follow during dimensioning. **2 hours**

Applied Geometry: Concept of plane and solid geometric construction, Bisecting and trisecting lines and angles, proportional division of lines, construction of angles, triangles, squares, polygons. Constructions using tangents and circular arcs. Methods drawing standard curves such as ellipses, parabolas, hyperbolas, involutes, spirals, cycloids and helices, solid regular objects such as: Prisms: Square, cubical, triangular and oblique, Cylinders: right and oblique, Cones: right and oblique. **4 hours**

Basic Descriptive Geometry: Application of descriptive geometry principles to the solution of problems involving positioning of objects in three-dimensional space. The Projection of points, lines and planes in space.

3 hours

Theory of Projection Drawing: Develop concept on projection, line of site, plane of projection, Fundamentals of Perspective projection drawing, orthographic projection, axonometric projection, oblique projection, first and third angle projection, systems and projection. **4 hours**

Multiview Drawings: Methods for obtaining orthographic views; Projection of lines, angles and plane surfaces, analysis in three views; Projection of curved lines and surfaces; Object orientation and selection of views for best representation; Full and hidden lines. Making an orthographic drawing; Visualizing objects from the given views; Interpretation of adjacent areas; True-length lines; Representation of holes; Conventional practices

3 hours

Sectional Views: Full section view, half section, broken section, revolved section, removed (detail) sections, phantom of hidden section, auxiliary sectional views, specifying cutting planes for sections, conventions for hidden lines, holes, ribs, spokes. **3 hours**

Auxiliary Views: Basic concept and use of auxiliary views, drawing methods and types of auxiliary views, symmetrical and unilateral auxiliary views, projection of curved lines and boundaries, line of intersection between two planes, true size of dihedral angles, true size and shape of plane surfaces. **3 hours**

Freehand Sketching and Visualization: Concept of size of paper & original scale, orientation of the object, minimum detail to communicate the idea, view of sketch, Techniques of sketching: Pencil hardness, squared paper, line densities, Techniques for horizontal, vertical and circular lines. **2 hours**

Developments and Intersections: General concepts and practical considerations for development of surfaces, Parallel line development, Radial line development, Triangulation development, Approximate development. **2 hours**

Topographical Drawings: Concept on developing topographical maps using the survey data, use of software such as AutoCad to develop the maps**.** **2 hours**

TEXTBOOKS AND REFERENCE BOOKS

1. W J Luzadder and J M Duff, Fundamentals of Engineering Drawing, 11th edition, Prentice-Hall of India, 2015. 704p
2. French, Thomas Ewing, Charles J. Vierck, and Robert J. Foster. Engineering Drawing and Graphic Technology. New York: McGraw-Hill, 1993. 745p
3. Frederick E. Giesecke, Ivan L. Hill, Henry C. Spencer, Alva E. Mitchell, John Thomas Dygdon, James E. Novak, Shawna E. Lockhart, Marla Goodman. Technical Drawing with Engineering Graphics. Peachpit Press, 14th Edition, 2011, 936p
4. N.D. Bhatt, V.M. Panchal, Machine Drawing, Charotar Publishing House, 49th Edition, 2014, 376p
5. P. S. Gill, A Textbook of Machine Drawing, S. K. Kataria and Sons,2013 Edition, 700p

SEMESTER: I *EGE 516*

Course Title: Applied Mathematics and Statistics Full Marks: 75
Course No.: EGE 516 Pass Marks: 37.5
Nature of the Course: Theory
Credit: 3 (45 hrs)

COURSE DESCRIPTION

The students will learn the use of mathematics and statistical knowledge in engineering geological problems.

OBJECTIVES

General Objectives. The students will have the knowledge and skill and knowledge on practical mathematics and statistics.

Specific Objectives. The main objectives of this course is to provide the students the skills of mathematics and statistics, learn the mathematical and statistical analysis of geological data.

COURSE CONTENTS

MATHEMATICS

Review. Limit, continuity, derivability of functions of a single variable, derivative rules and formulas, integration rules and standard integrals. **1 hour**

Mathematics as a tool for solving geological problems. Introduction, Mathematics as an approximation to reality, Using symbols to represent quantities, Subscripts and superscripts, Large numbers and small numbers, Manipulation of numbers in scientific notation, Use consistent units, Spreadsheets, Exercises: From Text Book (Mathematics. A Simple Tool for Geologists) 1.1, 1.2, 1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12. **4 hours**

Common relationships between geological variables. Introduction, The straight line, Quadratic equations, Polynomial functions, Negative powers, Fractional powers, Allometric growth and exponential functions, Logarithms, Logarithms to other bases, Exercises: Form Text Book (Mathematics. A Simple Tool for Geologists) 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,2.8, 2.9, 2.10, 2.11, 2.13, 2.14, 2.15. **3 hours**

Equations and their manipulations. Introduction, Rearranging simple equations, Combining and simplifying equations, Manipulating expressions containing brackets, Rearranging of quadratic equations, Exercises: From Text Book (Mathematics. A Simple Tool for Geologists) 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 ,3.7, 3.8, 3.9, 3.10, 3.11, 3.12. **3 hours**

More advanced equation manipulation. Introduction, Expressions involving exponentials and logarithms, Simultaneous equations, Quality assurance, Exercises: From Text Book (Mathematics. A Simple Tool for Geologists) 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10. **3 hours**

Trigonometry. Introduction, Trigonometric functions, Determining unknown angles and distances, Cartesian coordinates and trigonometric functions of angles, Trigonometry in a three-dimension, Introduction to vectors, Exercises: From Text Book (Mathematics. A Simple Tool for Geologists) 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,5.10, 5.16. **1 hour**

Graphs and representation. Introduction, Log-normal and log-log graphs, Triangular diagrams, Polar graphs, Equal interval, equal angle and equal area, projections of a sphere, Exercises: From Text Book (Mathematics. A Simple Tool for Geologists) 6.1, 6.2, 6.3, 6.4, 6.5, **2 hour**

Matrix Algebra. The Matrix, Elementary Matrix Operations, Matrix Multiplication, Inversion and Solution of Simultaneous Equations, Determinants, Eigenvalues and Eigenvectors, Eigenvalues, Eigenvectors, Exercises: From the Text Book (Statistics and Data Analysis in Geology, John *C.* Davis) 3.1, 3.2, 3.3, 3.4 and 3.5. **1 hour**

Vectors in two and three dimensions. Two and three dimensional vectors, scalar products, vector products, lines and planes.

1 hour

Differential calculus. Introduction, Rates of geological processes, Graphical determination of rates of change, Algebraic determination of the derivative, Standard forms, The product rule, The quotient rule, The chain rule, Why Calculus in geological science, Higher derivatives, Maxima and minima, Higher order derivatives, mean value theorems, taylor and maclaurin series, tangent and normal, curvature, asymptotes, curve tracing, exercises: From Text Book (Mathematics. A Simple Tool for Geologists) 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7,8.8, 8.9, 8.10, 8.11, 8.12, 8.13, 8.15. **3 hour**

Integral calculus. Introduction, Exercise for the area under the curve, Indefinite integration, Definite integration, Integration of more complex expressions, Applications of integration, Integrating discontinuous functions, Applications of Integral, Areas, lengths, volumes, surfaces, Exercises: From Text Book (Mathematics, A Simple Tool for Geologists) 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8.

STATISTICS

Statistics in Geology, Measurement Systems

Elementary Statistics

Probability, Continuous Random Variables, Statistics and descriptive statistics, Joint Variation of Two Variables, Induced Correlations, Log ratio Transformation, Comparing Normal Populations, Central Limits Theorem , Testing the Mean P-Values, Significance, Confidence Limits, the t-Distribution, degrees of freedom, confidence intervals based on t, A test of the equality of two sample means, the t-test of correlation, The F-Distribution, F-test of equality of variances, Analysis of variance, Fixed, random, and mixed effects, Two-way analysis of variance, Nested design in analysis of variance, The Chi square Distribution, Goodness-of-fit test , The Logarithmic and Other Transformations, Nonparametric Methods, Mann-Whitney test, Kruskai-Wallis test, Nonparametric correlation, Kolmogorov-Smirnov tests, Exercises: Selected exercise from the Text Book (Statistics and Data Analysis in Geology, John *C.* Davis) 2.1, 2.2, 2.3, 2.8, 2.9, 2.11, 2.12, 2.15, 2.16. 2.17.

4 hours

Analysis of Sequences of Data

Geologic Measurements in Sequences, Interpolation Procedures, Series of Events, Runs Tests, Least-Squares Methods and Regression Analysis, Confidence belts around a regression, Calibration, Curvilinear regression, Reduced major axis and related regressions, Structural analysis and orthogonal regression, Regression through the origin , Logarithmic transformations in regression, Weighted regression, Autocorrelation, Cross-correlation, Cross-correlation and stratigraphic correlation, Semivariograms, Modeling the semivariogram, Alternatives to the semivariogram, Spectral Analysis, Exercises: Selected exercise from the Text Book (Statistics and Data Analysis in Geology, John *C.* Davis), 4.2, 4.3, 4.7, 4.8, 4.12, 4.17. **4 hours**

Spatial Analysis

Geologic Maps, Systematic Patterns of Search, Distribution of Points, Uniform density, Random patterns, Clustered patterns, Nearest-neighbor analysis, Distribution of Lines, Analysis of Directional Data, Testing hypotheses about circular directional data, Test for randomness, Test for a specified trend, Test of goodness of fit, Testing the equality of two sets of directional vectors, Spherical Distributions, Matrix representation of vectors, Displaying spherical data, Testing hypotheses about spherical directional data, A test of randomness, Fractal Analysis, Ruler procedure, Grid-cell procedure, Spectral procedures, Higher dimensional fractals, Shape, Fourier measurements of shape, Spatial Analysis by ANOVA, Computer contouring, Contouring by triangulation, contouring by gridding, Problems in contour mapping, Extensions of contour mapping, Trend Surfaces, statistical tests of trends, Two trend-surface models, Pitfalls, Kriging, Simple kriging, Ordinary kriging, Universal kriging, calculating the drift, block kriging, Statistical model validation, ROC and area under the curve, Exercises: Selected exercise from the Text Book (Statistics and Data Analysis in Geology, John *C.* Davis) 5.1, 5.4, 5.7, 5.9, 5.12, 5.14, 5.15, 5.17, 5.`8, 5.19. **4 hours**

Analysis of Multivariate Data

Multiple Regression, Discriminant Functions, Tests of significance, Multivariate Extensions of Elementary Statistics, Equality of two vector means, Equality of variance-covariance matrices, Cluster Analysis.

Introduction to Eigenvector Methods, Including Factor Analysis, Principal Component Analysis, Closure effects on principal components, R-Mode Factor Analysis, Factor rotation, Maximum likelihood factor analysis, Q-Mode Factor Analysis , A word about closure, Principal Coordinates Analysis, Correspondence Analysis

,Multidimensional Scaling, Simultaneous R- and Q-Mode Analysis, Multigroup Discriminant Functions, Canonical Correlation, Exercises: Selected exercise from the Text Book (Statistics and Data Analysis in Geology, John *C.* Davis) 6.1, 6.6, 6.11, 6.16, 6.17, 6.19

3 hours

TEXT BOOKS

1. Mathematics. A Simple Tool for Geologists, David *Waltham, Second edition, Blackwell Science Ltd, London, 217p.*
2. Statistics and Data Analysis in Geology, John *C. Davis, Third Edition, John Wiley & Sons, New York, 620 p.*
3. E.W. Swokowski. Calculus with Analytic Geometry, *Second Alternate Edition, PWS-Kent Publishing Co., Boston.*

REFERENCE BOOKS

1. E. Kreyszig. Advance Engineering Mathematics*, Fifth Edition, Wiley, New York.*

SEMESTER: I *EGE 517*

Course Title: Practical I: Petrology and Sedimentology Full Marks: 25
Course No.: EGE 517 Pass Marks: 12.5
Nature of the course: Practical
Credit: 1 (45 hrs)

COURSE DESCRIPTION

The students will study igneous, sedimentary and metamorphic rocks in hand specimen and thin-section. In sedimentology, they will study sediments.

OBJECTIVES

General Objectives. To provide students with the knowledge and skills of rocks study, its description and interpretation in hand specimens and polarizing microscope and sediment study under unaided eyes and binocular microscope as well as using sieving techniques.

Specific Objectives:

- Study of rocks in hand specimens and thin-sections to describe their textures, structures, mineralogy and origin.
- Study of sediments under unaided eyes, binocular microscope and sieves methods

COURSE CONTENTS

Petrology and Sedimentology Practicals

Lab 1: Study of optical properties of some rock forming minerals under the polarizing microscope

Lab 2: Study of igneous and metamorphic rocks in hand specimens and under the polarizing microscope

Lab 3: Study of siliciclastic rocks in hand specimens and under polarizing microscope

Lab 4: Study of carbonate rocks in hand specimens and under polarizing microscope

Lab 5: Grain size analysis of unconsolidated gravelly and sandy sediments using sieve methods.

Lab 6: Grain size analysis of unconsolidated silts and clay sediments using pipette method.

Lab 7: Analysis of sphericity, roundness and surface features of unconsolidated sands under binocular microscope

Lab 8: Analysis of particle composition, form, sphericity, roundness, and surface features of unconsolidated gravelly sediments

Lab 9: Construction of velocity distribution in stream channel and discharge calculation using Area-Velocity Method.

Lab 10: Plotting of sediment rating curve using published data on discharge and suspended sediment concentration of Himalayan rivers from Department of Hydrology and Meteorology, Government of Nepal.

SEMESTER: I *EGE 518*

Course Title: Practical II: Engineering Drawings Full Marks: 25
Course No.: EGE 518 Pass Marks: 12. 5
Nature of the Course: Practical
Credit: 1 (45 hrs)

COURSE DESCRIPTION

Students will learn the concepts of sketching, drafting skills and make familiar with standard symbols of different engineering fields to understand the engineering drawings.

General Objectives. The course aims to develop basic concepts on projection with reference to points, lines, planes and geometrical solids and to make familiar with the conventional practices of sectional views and software uses.

COURSE CONTENTS

1. Drawing Sheet Layout, Freehand Lettering, Sketching of parallel lines, circles, Dimensioning - **3 hours**
2. Applied Geometry (Sketch and Instrumental Drawing) - **3 hours**
3. Descriptive Geometry : Projection of Point, Lines and planes - **6 hours**
4. Multiview Drawings, Sectional Drawings and Dimensioning - **6 hours**
5. Projection of Regular Geometrical Solids (Sketch and Instrumental Drawing) - **3 hours**
6. Familiarization with Graphical Symbols (Symbols for Different Engineering Fields) - **3 hours**
7. Detail Drawing - **6 hours**
8. Assembly Drawing - **3 hours**
9. Building Drawing - **6 hours**
10. 3d sketch using Autocad - **6 hours**

REFERENCE BOOKS

1. W J Luzadder and J M Duff, Fundamentals of Engineering Drawing, 11th edition, Prentice-Hall of India, 2015. 704p
2. French, Thomas Ewing, Charles J. Vierck, and Robert J. Foster. Engineering Drawing and Graphic Technology. New York: McGraw-Hill, 1993. 745p
3. Frederick E. Giesecke, Ivan L. Hill, Henry C. Spencer, Alva E. Mitchell, John Thomas Dygdon, James E. Novak, Shawna E. Lockhart, Marla Goodman. Technical Drawing with Engineering Graphics. Peachpit Press, 14th Edition, 2011, 936p
4. N.D. Bhatt, V.M. Panchal, Machine Drawing, Charotar Publishing House, 49th Edition, 2014, 376p
5. P. S. Gill, A Textbook of Machine Drawing, S. K. Kataria and Sons,2013 Edition, 700p

SEMESTER: I *EGE 519*

Course Title: Practical III: Structural Geology Full Marks: 25
Course No.: EGE 519 Pass Marks: 12. 5
Nature of the Course: Practical
Credit: 1 (45 hrs)

COURSE DESCRIPTION

The students will learn to interpret structural features and stratigraphy from the geological maps, and lean the techniques of stereographic projections to handle structural data.

OBJECTIVES

General Objectives. To provide students with the knowledge and skills about interpretation of geological maps and cross-section, and use of stereographic projections in structural geology.

Specific Objectives:

- Use of topographic maps to make crossections, prepare, interpretations and preparation of crossections from given geological maps.
- Plotting geologic data on stereonets and their interpretations. Orthographic projection of structural data and problem solving and borehole data analysis.

COURSE CONTENTS

STRUCTURAL GEOLOGY PRACTICAL

Lab 1: Contours and topography. Relationship between contours and geologic contacts. Rule of V's.

3 hours

Lab 2: Study of structural features and stratigraphic sequence of the given geological maps. **3 hours**

Lab 3 -8: Study of geological maps and preparation of geological cross-sections of horizontal, inclined, vertical, and folded beds. Study of geological maps with unconformity, faults, and dykes. Apparent and true thickness of beds. Determination of throw of faults. **18 hours**

Lab 9-11: Stereographic projection techniques. Plotting a line and a plane on the stereo net. Pole to the plane. Pole net and its use. Trend, plunge, and pitch of a line and their representation on the stereo net. Dip and strike of a plane and their representation on the stereo net. Apparent dip and true dip. Line of intersection of two planes. Pi and beta diagrams. Rotation of structural data by using the stereo net. Contouring techniques. **9 hours**

Lab 12-13: Three - point - problems. Borehole data analysis and interpretation. Depth and distance calculations. True and apparent dips. Calculation of vertical and horizontal throw. **6 hours**

Lab 14-15: Fault Problem: Geometrical and stereographic techniques for the determination of net slip, dip slip, and strike slip along the fault planes. **6 hours**

STRUCTURAL GEOLOGY TEXTBOOKS

1. Hobbs, B. E., Means, W. D., and Williams, P. F. (1976). An Outline of Structural Geology, *John Wiley and Sons, 571 p.*
2. McClay, K. R. (1987). The Mapping of Geological Structures, *John Wiley and Sons Inc., 161 p.*
3. Ragan, D. M. *(1985).* Structural Geology, An Introduction to Geometrical Techniques, 3rd edition, *John Wiley and Sons Inc., 393 p.*
4. Chorley, R. 3, Schumm, S.A., and Sugden, D.E. (1984). Geomorphology, *Methuen, 605p.*
5. Thornbury, D. W. (2000). Principles of Geomorphology, *New age International (P) Limited, Publishers, India. 594 p*

SEMESTER: I *EGE 520*

Course Title: Field works Full Marks: 25
Course No.: EGE 520 Pass Marks: 12.5
Nature of the course: Field
Credit: 1 (9 days in field)

COURSE DESCRIPTION

The students will learn to read topographic maps and locate oneself on the map, identify and map rocks and minerals, identify and interpret structures in the field, prepare geological map and crossections, learn various surveying techniques and learn about geology and tectonics of the Nepal Himalaya.

OBJECTIVES

General Objectives. The main objective of this course is to give the knowledge, techniques and skill of geological mapping and surveying.

Specific Objectives. Identifying rocks and minerals in the field, their recording in field note books, measurement of dip, strike and other structural features, identifying various structures and their interpretations, preparation of geological maps and crossections. Surveying and route mapping.

COURSE CONTENT

The students will spend a total of 9 days in the field studying under supervision of the faculties. Students will learn to identify the rocks and minerals in the field, mapping and describing structures, and learn techniques and skills of observation, data recording, sampling, description, analysis and interpretation, learn about route mapping and preparation of geological maps, cross-sections and stratigraphic columns.

They will also learn to study weathering and erosion processes, and field characteristics of soil and study soil profiles. Students will also learn the basic surveying techniques. At the end of the field work the students should be able to describe rock outcrops, map rock outcrops, Interpret rocks, textures and structures and describe and interpret folds faults, joints and other geological structures and prepare a geologic map. Also, learn the different tectonic units of the Nepal Himalaya. Students are required to prepare a geological map in the scale of 1:25000 and route map in 1:5000 scale, and also prepare a detailed columnar section.

The fieldwork will be carried out in Lesser Himalayan region and visit various districts of Nepal. This will give the students the opportunity to observe rock types, structures and tectonics of the Himalaya.

Detail course for the field works:

Days of Field	**Descriptions**	**Credit 1: (56 field work lecture hours)**
Day 1	Departure to the fieldwork area; orientation and preparation for desk works	7 hours
Day 2	Geological Traverse	7 hours
Day 3	Geological Traverse	7 hours
Day 4	Route Mapping (1:5000 scale)	7 hours
Day 5	Route Mapping (1:5000 scale)	7 hours
Day 6	Geological Mapping of a given area (1:25000 scale)	7 hours
Day 7	Geological Mapping of a given area (1:25000 scale)	7 hours
Day 8	Geological Field Report writing	4 hours
Day 9	Field Viva and Return back from the fieldwork area	3 hours
	TOTAL	= 56 hours

Evaluation:

S.N.	Evaluation schemes	Marks in %	Marks in %
1	Fieldwork Task Performance	20%	80%
2	Field Attendance	20%	
3	Field Discipline	20%	
4	Field Report and Viva	20%	
5	Final Viva Voce and Fieldwork Presentation	20%	20%

TEXTBOOKS

1. Thrope R. S. and Brown G. C. (1995). The field description of igneous rocks, John Wiley and Sons, 154p.
2. Barnes, J. W. (1981). Basic Geological Mapping. Geological Society of London Handbook Series. No. 1, Open University Press.
3. Bowden, J. (2008). Writing a Report: how to Prepare, Write and Present Really Effective Reports. ISBN-10:1845282930, 223p.
4. McClay, K. R. (1987). The Mapping of Geological Structures. Open University Press, Milton Keynes, 161p.
5. Bennison, G. M. (1987). An Introduction to Geological Structures and Maps. Edward Arnold, London, 65p.
6. Tucker M. (1982). The field description of sedimentation rocks. Geological Society of London Handbook Series, No. 1, Open University Press.
7. Fry, N. (1984). The field description of metamorphic rocks. Geological Society of London Handbook Series, No. 3, Open University Press.

REFERENCE BOOKS

1. Lisle, R. J. (1995). Geological Structures and Maps: A Practical Guide, 2nd Edition, Butterworth-Heinemann,Oxford, 104p.
2. Maltman, A. (1998). Geological maps: an introduction, 2nd Edition, John Wiley.
3. Gansser, A. (1964). Geology of the Himalayas, John Wiley and Sons Inc.
4. Journal of Nepal Geological Society (Various Issues)
5. Bulletin of Department of Geology (Various Issues)