

05

TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	40
Programme	BCE	Pass Marks	16
Year / Part	II / I	Time	1 ½ hrs.

Subject: - Engineering Geology I (CE503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Define engineering geology and discuss the importance in civil engineering. [1+2]
2. Define plate tectonics and discuss the evolution of Himalaya. [3]
3. What is Mohs scale of Hardness? Describe the symmetry of crystal in detail. [1+2]
4. a) How do you differentiate Igneous rock and Sedimentary rocks in the field? [4]
b) Write down the physical and engineering properties of Marble, Slate and amphibolite. [6]
5. a) Define fault with neat diagram and discuss its importance in civil engineering. [4]
b) What is unconformity? Why unconformity is important in geological structure in civil engineering. [4]
6. a) What are geological agents? Describe the erosional landform developed by glaciers. [2+4]
b) Differentiate between Conglomerate and Agglomerate. [2]
7. Mention the geomorphic sub-division of Nepal Himalaya and describe lesser Himalaya in detail. [2+3]

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Programme	BCE	Pass Marks	16
Year / Part	II / I	Time	1 ½ hrs.

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- ✓ Attempt ***All*** questions.
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1. Describe the scope and objective of engineering geology in the field of civil engineering. [2]
2. What do you mean by Plate Tectonics? Differentiate between transform and divergent plate boundary. [2+2]
3. Write down the optical properties of minerals in Handspecimens. [3]
4. a) How do you differentiate three rock types in the field? [4]
b) Write down the physical and engineering properties of phyllite, Granite and Limestone. [6]
5. a) Define joint and discuss the geometric classification of joint with its engineering importance. [4]
b) Determine the dip direction of a bedding plane of limestone bed which has strike N55°E and dip amount 30°. [4]
6. a) What is geological cycle? Describe the depositional landform by wind. [2+4]
b) What is Volcano? Discuss the positive topography developed by volcano. [2]
7. Classify the Nepal Himalaya based on lithology and describe higher Himalaya in detail. [2+3]

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- ✓ Attempt All questions.
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1. Define engineering geology as per IAEG. Describe scope of petrology and structural geology in the field of civil engineering in brief. [1.5+1.5]
2. Describe internal structure of the earth with suitable diagram. What are the basis of the study of internal structures? [2+1]
3. How do you classify minerals? Describe Isometric system with symmetry elements. [1.5+1.5]
4. a) Define and describe texture of sedimentary rocks. Describe rock cleavage. [3]
b) What are the basis of rock identification in the field? [3]
c) Describe physical and engineering properties of Limestone, phyllite and Granite. [3]
5. a) How is rock deformed? Describe type and stage deformation of rock. [3]
b) How do you classify Joint? [3]
c) What is relationship between strike and dip? How do you calculate apparent dip amount from measured true dip amount? [3]
6. a) Describe landform developed by erosion and deposition by running water and glacier. [5]
b) What is volcanism? Describe chemical weathering. [3]
7. a) Describe physiographic division of Nepal Himalaya. [3]
b) Describe classification of Terai zone with lithology. [2]

Examination Control Division

2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	40
Programme	BCE	Pass Marks	16
Year / Part	II / I	Time	1 ½ hrs.

Subject: - Engineering Geology I (CE503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **All** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.

1. Mention relationship between civil engineering and Geology. [2]
2. Describe plate boundary. How is mountain formed? [3]
3. Describe physical properties of minerals. What are the elements of symmetry of orthorhombic system? [2]
4. a) How do you differentiate petrography and petrogenesis? Describe classification of sedimentary rocks. [1+3]
- b) Describe engineering properties, texture and structure of schist, sandstone and Phyllite. [6]
5. a) Describe criteria for identification of fault in the field. [2]
- b) How do you classify fault and joint genetically? Describe. [4]
- c) How do you calculate apparent dip amount, when true dip amount is measured? [4]
6. a) Describe factors for weathering. Mention erosional and depositional landform of wind. [1+4]
- b) Describe classification of volcano. [3]
7. Describe lithological characteristics of Higher Himalaya and Tethys zone. Describe altitude and lithology of churiya range, fore Himalaya and Trans Himalaya. [2+3]

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Programme	BCE	Pass Marks	16
Year / Part	II / I	Time	1 ½ hrs.

Subject: - Engineering Geology I (CE503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Mention the importance of geology in civil engineering. [2]
2. How is Himalaya formed? Describe internal structure of the earth in brief. [1+2]
3. How do you define Hardness of mineral? Describe isometric system of crystal. [1+2]
4. a) How do you identify three rock types in field? Describe texture of sedimentary rock. [2+2]
b) Describe texture, structure, mineral composition and engineering properties of quartzite, limestone and Granite. [6]
5. a) How do you differentiate fault and thrust? What are field evidences of fold? [2+2]
b) Determine the strike direction of bedding plane when dipdirection in N40°W. [4]
c) Describe deformations in rock strata. [1]
6. Define weathering. Describe depositional
a) Features developed by river [2+3]
b) Mention erosional features of glacier and underground water. [3]
7. Explain geological division of Terai and siwalik zone. Describe lithology and altitude range of Dun valley and midland. [3+2]

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Year / Part	II / I	Time	1½ hrs.

Subject: - Engineering Geology I (CE503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. What are the importances and objectives of engineering geology course in civil engineering? [1+1]
2. Mention any three evidences of plate tectonics. [2]
3. Define moh's scale of hardness. Describe crystal symmetry. [1.5+1.5]
4. a) Describe rock cleavage. Write down the physical and engineering properties of limestone, phyllite and granite. [2+3]
- b) Write down the formation process of metamorphic rock. Describe texture of igneous rock. [5]
5. a) Describe about attitude of rock. What are the differences between true and apparent dip? [2+2]
- b) What is joint? Point out engineering significance of joint and fault. [2+4]
6. What is volcano? Briefly describe about location and types of volcano. [1+3]
7. Describe different land forms produced by river. [4]
8. What are physiographic divisions of Nepal Himalaya. Describe the lithology of Tibetan-Tethys zone. [3+2]

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Level	BE	Full Marks	40
Programme	BCE	Pass Marks	16
Year / Part	II / I	Time	1½ hrs.

Subject: - Engineering Geology (CE 503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Mention the different branches of engineering geology. Write in brief the internal structure of earth. [1+3]
2. What are the physical and optical properties of minerals? [4]
3. What are the engineering significance of three rock classes? [4]
4. Explain fault, fold and joint. Define the attitude of geological structure. [3+2]
5. Write short notes on: i) Conglomerate (ii) Shale (iii) Slate (iv) Marble (v) Granite [1×5]
6. Write short note on primary and secondary structures of geology. [5]
7. Mention different geological agents and explain the geological cycle. [4]
8. Define weathering and erosion. Write short notes on volcanism. [4]
9. What are the tectonic division of Nepal? Explain the geology of lesser Himalaya zone. [5]

Exam.	Regular / Back		
	Level	BE	Full Marks
Programme	BCE	Pass Marks	16
Year / Part	II / I	Time	1½ hrs.

Subject: - Engineering Geology I

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. What is the importance of Geology? What are different branches of geology? [1+1]
2. Define plate tectonics? Define features of the earth surface? [1+1]
3. What are the physical properties of minerals? [2]
4. What is the stage of deformation? Describe types of unconformity. Mention any two civil engineering significance of marble. [1.5+1.5+1]
5. Define attitude of bedrock. Determine the strike direction of bedding plane of Limestone bedrock, which dips towards N31°W. [1+4]
6. a) Mention the difference between weathering and erosion? What are the different geological agents? [2+2]
b) What are different volcanic materials? What are the basis on which volcanoes are classified? [2+2]
7. a) How do you differentiate fault and joint? How is sedimentary rock formed? [2+2]
b) Describe the texture of sedimentary rocks. [4]
8. Write short notes on: (any three) [3×3]
 - a) Geology Terai Zone
 - b) Forms of Igneous Rock
 - c) Crust
 - d) Main Frontal Thrust

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Geology

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Define engineering geology as per IAEG. Describe mechanism of earthquake. [3+5]
 b) Define plate tectonics. Describe importance of engineering geology in context of Nepal. [2+6]
2. a) Define crystals. Describe physical properties of minerals. [2+6]
 b) Describe rock cycle. How are sedimentary rocks formed? Describe texture of igneous rocks. [3+2+3]
3. a) Define fold and fault. Describe parameters of rock mass rating system in brief. [1+1+6]
 b) Define mass movement. Describe preventive measures from landslide. Point out engineering classification of rock mass. [3+3+2]
4. a) Define river channel morphology. Describe engineering significance of meandering river channel. [3+5]
 b) Describe methods of surface site investigation. Mention importance of engineering geological map. [6+2]
5. a) Describe geological division of Nepal Himalaya. Mention civil engineering importance of thrusts. [5+3]
 b) Three boreholes A, B and C are drilled in a dam site of a hydropower project. Bore hole A lies 500m due north of Bore hole B and Bore hole C lies 400m due east of Bore hole B. A highly jointed and fractured bedrock is encountered in following depth from M.S.L. as below. [8]

	Top	Bottom
Bore hole A	300	310m
Bore hole B	280	290m
Bore hole C	310	320m

Find out the altitude of jointed and fractured bed rock.

6. a) Write short notes on: (any four) [2×4]
 - i) Seismic waves
 - ii) Isometric system
 - iii) Types of deformation
 - iv) Moh's scale of hardness
 - v) Darcy's law
- b) Differentiate between: (any four) [2×4]
 - i) Recumbent and overturned fold
 - ii) Strike and streak
 - iii) Convergent and divergent plate boundaries
 - iv) Landslide and debris flow
 - v) Magma and lava

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Geology

- ✓ Candidates are required to give their answers in their own words as far as practicable.
 - ✓ Attempt any **Five** questions.
 - ✓ The figures in the margin indicate **Full Marks**.
 - ✓ Assume suitable data if necessary.
1. a) What is Engineering Geology different from General Geology? Describe it's importance in the field of Civil Engineering. Mention the internal structures of earth. [1+3+4]
b) Define and describe type of seismic waves. Write down the mechanism of earthquake origination. [3+5]
 2. a) Define minerals. Describe different types of crystal systems with illustrations. [2+6]
b) What are different types of rocks? Describe rock cycle with diagram. Describe the physical properties of major sedimentary rocks in Nepal Hiamalaya. [2+6]
 3. a) Define rock cleavage. Describe types of cleavages. Mention civil engineering significance of rock cleavage. [2+4+2]
b) What is river morphology? Why should a civil engineer learn about it? [3+5]
 4. a) Define mass movements. Mention the classification system of mass movement by varnes. [3+5]
b) How does water flow under the ground? Describe Darcy's law and its applicability. [3+5]
 5. What are the differences between: [4×4]
 - a) Intrusive and extrusive rocks
 - b) Confined and unconfined aquifer
 - c) Strike and streak
 - d) Syncline and anticline fold
 6. Write short notes on: [4×4]
 - a) Moh's Scale of Hardness
 - b) Rock Quality Designation (RQD)
 - c) Attitude of Bedrock
 - d) Quartzite

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Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Geology

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- ✓ Attempt any **Five** questions.
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1. a) Define engineering geology. Describe the scope and objectives of engineering geology in civil engineering field. [2+6]
b) Describe the internal structure of earth with suitable diagram. Explain the various landforms on the surface of the earth. [4+4]
2. a) Define crystal and elements of crystal symmetry. Describe orthorhombic system with suitable diagram and give examples of three minerals belonging to monocline system. [1+2+3+2]
b) Define minerals. Describe the physical properties of mineral. Point out the engineering significance of Rock-forming minerals. [1+5+2]
3. a) Define Metamorphic Rock and its types. Explain the structure of Metamorphic Rock. Give the significance of igneous Rocks in civil engineering activities. [2+4+2]
b) Define joint in rock mass. Classify the rock joints with diagram. Explain the effects of joints. [2+3+3]
4. a) What is fault? Write down its causes. Classify fault with suitable diagram. State effects of fault on the strength of slope as a whole. [2+4+2]
b) What are different types of rivers Nepal? Explain the features developed by rivers with suitable diagram. State their engineering significance as well. [3+3+2]
5. a) Define topographic map, aerial photograph and engineering geological map. Write down the importance of engineering geological map for site investigation. [3+5]
b) Describe the tectonic division of Nepal with neat sketch. Point out the tectonic boundaries on the sketch. What are the challenges to be faced due to geological setting of Nepal? [8]
6. a) Point A is 600m North of point B and point C is 300m East of point B. The altitudes of A, B and C are 500m, 400m and 400m respectively. Find the attitude of the bed rocks bedding plane of which is passing through these points. [8]
b) Write short notes on any four: [4×2]
 - i) Fold Cleavage
 - ii) Unconformity
 - iii) Bone Hole Log
 - iv) Debris Flow
 - v) Plate Tectonic

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Subject: - Engineering Geology

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- ✓ Attempt any **Five** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.

1. a) Define Engineering Geology in the statutes of IAEG. Describe its scope in the field of civil engineering. [3+5]
b) Describe different terminologies of earthquake with necessary diagram. Describe the points that should be taken into consideration for the construction of civil engineering structures in seismic. [4+4]
2. a) Explain different crystal systems with diagram. Mention two points to clarify why quartz is the most resistant mineral. Mention the properties of feldspar and mica group of minerals. [3+2+3]
b) What is rock cycle? How does it represent the sequences of formation of different rock types? Describe the texture of igneous rock. [1+3+4]
3. a) Describe different components to express the orientation of rock bed. Differentiate between true dip and apparent dip with suitable diagram. [4+4]
b) Define an unconformity. Describe the various stages in the formation of an unconformity with diagram. Also describe its engineering significance in the construction of civil engineering structures. [2+3+3]
4. a) Differentiate between landslide and slope failure. Describe different types of mass movements in brief. [3+5]
b) Describe Darcy's law. Explain different types of river channels mentioning the engineering significances of each type. [2+6]
5. a) Describe Geology in Nepal with neat sketch indicating different types of tectonic boundaries. Explain the engineering related problems at such boundaries. [8]
b) Define RMR system of rock mass classification. Describe different parameters of RMR system. [2+6]
6. a) Point A is 800N of point B and point C is 600m east of Point B. The altitudes of A, B, and C are 600m, 200m and 500m respectively. Find the attitudes (strike, dip direction and dip amount) of the bed rock whose bedding plane passes through these points. [8]
b) Describe various methods of site investigation for road construction. Discuss in brief the relation between hill slope and orientation of discontinuities to investigate the slope stability condition. [5-3]

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Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Geology

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1. a. Define engineering geology. Describe its importance in civil engineering practice with justifications. (2+6)
- b. How earthquake occurs? Define different terminologies of earthquake. Describe the causes and effects of earthquake. (2+3+3)
2. a. Defines crystal. Describe different crystal systems with examples. What are the symmetry elements of crystal? (1+4+3)
- b. Define mineral. Describe physical properties of mineral. Point out the engineering significances of rock forming minerals; quartz, calcite, feldspar and mica. (2+4+2)
3. a. Define rock and rock cycle. Describe the texture of igneous rock. Describe engineering importance of three rock types in brief. (1+1+3+3)
- b. Define fold, fault, joint and thrust. Describe engineering significance of each of the above mentioned geological structure in tunneling. (4+4)
4. a. Describe method of site investigation in different phases. How fault influences in the site selection criteria? Describe geological investigation of dam and reservoir. (3+2+3)
- b. Point A is 600 N of point B and Point C is 400 m west of Point B. The altitudes of A, B, and C are 400 m, 100 m and 300 m respectively. Find the attitudes (strike, dip direction and dip amount) of the bed rock whose bedding plane passes through these points. (8)
5. a. Describe different types of river channel. Describe the significances of each type of river channel, if you have to launch a hydropower project on them. (3+5)
- b. Describe mass movement. Mention mitigative measures for rock slope instability. Justify "All mass movements are landslide but all landslides are not mass movement". (2+3+3)
6. a. Write short notes on : (any four) 4x2=8
 - i. Factor of safety
 - ii. Weathering profile
 - iii. Mountain system
 - iv. Plate boundaries
 - v. Darcy's Law
 - vi. Unconformity
- b. Differentiate between : (any four) 4x2=8
 - i. Permeability and Hydraulic Conductivity
 - ii. Calcite and Quartz
 - iii. Garnet and Granite
 - iv. Magnitude and Intensity of earthquake
 - v. Plutonic and Volcanic rock
 - vi. Plane failure and Wedge failure.

Exam.	Regular/Back		
	Level	B.E.	Full Marks
Programme	BCE	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Geology

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- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Define crystal and elements of crystal symmetry. Describe orthorhombic crystal system with suitable diagram and give examples of three minerals belonging to isometric system. [1+2+3+2]
- b) Define metamorphism and metamorphic rock. Describe different types of rock cleavage found in metamorphic rocks. Give their engineering significance. [1+1+3+3]
2. a) What is an unconformity? How can it be recognized in the field? What problems are created by the presence of unconformities? [2+2+4]
- b) Define rock mass and rock material. Explain the characteristics of discontinuities in the rock mass. [2+6]
3. a) Define landslide and mention its various parts with illustration. Describe different types of preventive measures to stabilize the landslide which occurs in the soil mass. [1+3+4]
- b) Describe various types of morphological features developed by river channels. Define hydrological cycle, permeability, porosity, aquifer, aquiclude. [2+6]
4. a) Describe tectonic divisions of Nepal with neat sketch. Indicate tentative location of the tectonic boundaries such as HFT, MBT and MCT. Explain problems related to engineering that can exist in such boundaries. [8]
- b) Describe the methods of surface and sub-surface investigations for the selection of a suitable site to construct civil engineering structures. [8]
5. a) Define true dip and apparent dip. Describe with illustration why it is important to consider apparent dip to draw cross-section when the line of cross-section is not perpendicular to the strike line. [1.5+1.5+5]
- b) Point A is 800m N of Point B and Point C is 400m west of Point B. The altitudes of A, B and C are 500m, 100m and 300m respectively. Find the attitudes (strike, dip direction and dip amount) of the bed rock whose bedding plane passes through these points. [8]
6. a) Write short notes on (any four): [4×2]
 - i) Moh's Hardness Scale
 - ii) Ox-bow Lake
 - iii) Folded Mountains
 - iv) Factor of Safety
 - v) Friction Angle
 - vi) Weathering Profile
- b) Differentiate between (any four): [4×2]
 - i) Confined and Unconfined Aquifer
 - ii) Gabbro and Basalt
 - iii) Body Wave and Surface Wave
 - iv) Hardness and Strength
 - v) Colour and Streak of Mineral

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- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Define engineering geology. Describe the scope and objectives of engineering geology in civil engineering practices in Nepal. [2+6]
- b) Explain intensity and magnitude of earthquake. Write down the mechanism as to how an earthquake occurs. Explain the different types of seismic waves generated during the earthquake. [2+2+4]
2. a) Describe symmetry elements and crystal systems with figure. Explain engineering significance of rock-forming minerals. [2+3+3]
- b) What is rock cycle? How does it represent the sequences of formation of different rock types? Describe the features for recognizing sedimentary, metamorphic and igneous rock. [1+3+4]
3. a) Define fault and illustrate different parts of fault. How is it recognized in the field? What engineering problems are created by the presence of fault? [2+3+3]
- b) What are planes of discontinuities in the rock masses? Explain their characteristics. [2+6]
4. a) What is landslide? Describe its causes. Explain the techniques to determine the slip surface of landslides. [1+3+4]
- b) Define permeability and state Darcy's law. Explain the various types of river channels mentioning the engineering significances of each type. [1+2+5]
5. a) Describe the tectonic divisions of Nepal with neat sketch. Indicate tentative location of tectonic boundaries such as HFT, MBT and MCT. Also explain the engineering related problems that can exist in such boundaries. [8]
- b) Describe the methods of surface and sub-surface investigations for the site selection to construct civil structures. [8]
6. a) Define topographic map, aerial photograph and engineering geological map. Explain the importance of engineering geological map for site investigation to construct civil structures. [3+5]
- b) Point A is 600m North of Point B and Point C is 300m East of Point B. The altitudes of A, B and C are 500m, 100m and 400m respectively. Find the attitudes (strike, dip direction and dip amount) of the bed rock, whose bedding plane is passing through these points. [8]

Exam.	Regular / Back		
Level	B.E.	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Geology

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Define engineering geology and list out major objectives of the engineering geological investigation for a hill-road project. [2+6]
- b) Draw a neat cross-section of the interior of the earth and mention the composition, density and temperature variation within the earth. List out the effects of the earthquake. [3+2+3]
2. a) Describe the geology of Nepal with a neat sketch and mention the engineering significance of the HFT, MBT and MCT. [3+2+3]
- b) List out the crystal symmetry with examples. Define rock forming minerals. Describe the feldspar group of minerals and list out the engineering significance of quartz. [2+1+3+2]
3. a) Classify the rocks and describe the engineering significance of the rock classes. [5+3]
- b) How sedimentary and metamorphic rocks are formed? [4+4]
4. a) What are folds? How the folds are recognized in the field? List out the influence of folded structures in civil engineering practice. [1+3+4]
- b) Write the genetic classification of faults. List out the physiographic evidences to recognize the faults in the field. Why the documentation of faults is essential in the civil engineering practice? [3+2+3]
5. a) Describe the planes of discontinuity in rock masses and write brief notes on Q and RMR system of engineering classification of rock masses. [2+3+3]
- b) List out the types of mass movement. What are the factors affecting the slope stability? Mention the preventive measures of the landslides. [3+3+2]
6. a) Describe the morphology of river channel and define porosity, permeability, aquifer, aquiclude and piezometric levels. [3+1+1+1+1+1]
- b) List out the complete direct and indirect methods of the site investigation for large dam in the middle mountain range of Nepal. [8]
7. Differentiate between any four of the following: [4×4]
 - a) Altitude and attitude
 - b) Petrification and metamorphism
 - c) Bedding and foliation
 - d) Fault gauge, fault breccia and mylonite
 - v) Rotary drilling and percussion drilling