ANNEXURE-D

INSTITUTE OF GEOLOGY, UNIVERSITY OF THE PUNJAB
LAHORE

COURSES AND SYLLABI

FOR

M.PHIL APPLIED GEOLOGY
(ENGINEERING GEOLOGY)

DURATION: **02 YEARS**
COURSE WORK: **24 CREDIT HRS**
THESIS WORK: **06 CREDIT HRS**

Course Code:	Course Title	Credit hrs
FIRST SEMESTER		
GEOL-501	**REGIONAL GEOLOGY (CORE-SUBJECT)**	**03**
GEOL-531	**SOIL MECHANICS-I**	**03**
GEOL-532	**ROCK MECHANICS-I**	**03**
GEOL-533	**ADVANCED HYDROLOGY**	**03**
SECOND SEMESTER		
GEOL-505	**RESEARCH METHODOLOGY AND TECHNICAL WRITING (CORE-SUBJECT)**	**03**
GEOL-534	**CONSTRUCTION MATERIALS**	**03**
GEOL-535	**ENGINEERING GEOLOGY**	**03**
GEOL-536	**SOIL MECHANICS-II**	**03**
GEOL-537	**ROCK MECHANICS-II**	**03**
GEOL-538	**HYDROGEOLOGY AND GROUNDWATER MODELING**	**03**

ANNEXURE-D

INSTITUTE OF GEOLOGY UNIVERSITY OF THE PUNJAB, LAHOURE

COURSE OUTLINE

M.PHIL APPLIED GEOLOGY
(ENGINEERING GEOLOGY)

Duration: **02 years**

Course Work: **24 Credit hours**

Thesis Work: **06 Credit hours**

FIRST SEMESTER

GEOL-501: REGIONAL GEOLOGY (CORE-SUBJECT, 03 Credit Hours)

The geology of Himalayas, Karakuram and Hindukush ranges. The geology and stratigraphy of the Salt Range, Sulaiman Range and Kirthar Range. The Katawaz Basin. The Makran and adjacent regions. The Chagai and adjacent regions. Ophiolites of the region. The Deccan traps and hot spots. The Geology of Indian Plate.

Books Recommended

1. Geodynamics of Pakistan, by A.Farah and K.DeJong, 1979, Elite Publishers, Karachi, Proceedings of the International Committee on Geodynamics.
2. Geology and tectonics of Pakistan by Kazmi, A.H., Jan, M.Q. (1997), Graphic Publishers, Karachi
3. Geology of Pakistan by Bender and Raza, 1995, Gebruder Borntraeger, Berlin.
4. Reconnaissance Geology of Part of West Pakistan, HSC, 1960.
5. Stratigraphy of Pakistan, by Kazmi and Abbassi, 2008.
6. Stratigraphy of Pakistan, S.M. Ibrahim Shah, 1997, GSP Memoir.
7. Stratigraphy of Pakistan, S.M. Ibrahim Shah, 2008, GSP Memoir (2nd Edition).

GEOL-531 SOIL MECHNICS-I (03 Credit hrs)

Soils and Rocks: Rock Cycle and the Origin of Soil, Soil Particles, Clay Minerals, Mechanical Analysis of Soil, Effective Size, Uniformity Coefficient, and Coefficient of Gradation,
Soil Composition: Weight-Volume Relationships, Unit Weight, Void Ratio, Moisture Content, and Specific Gravity Relationships, Unit Weight, Porosity, and Moisture Content Relationships, Relative Density, Consistency of Soils, Unified Soil Classification System.
Soil Compaction: General Principles, Standard Proctor Test, Factors Affecting Compaction, Modified Proctor Test, ASTM and AASHTO Specifications for Compaction Test, Structure of Compacted Cohesive Soil, Effect of Compaction on Cohesive Soil Properties, Field Compaction, Specifications for Field Compaction, Determination of Field Unit Weight of Compaction, Special Compaction Techniques.
Flow of Water in Soil: Permeability and Seepage: Hydraulic Gradient, Darcy's Law, Coefficient of Permeability, Laboratory Determination of the Coefficient of Permeability, Effect of Temperature on Coefficient of Permeability, 4.6 Equivalent Permeability in Stratified Soils, Permeability Test in Field by Pumping From Wells, Coefficient of Permeability from Auger Holes, Equation of Continuity, Flow Nets, Uplift Pressure under Hydraulic Structures.
Effective Stress Concept: Stresses in Saturated Soil without Seepage, Stresses in Saturated Soil with Seepage, Seepage Force, Heaving in Soil due to Flow around Sheet Piles, Effective Stress in Partially Saturated Soil, Capillary Rise in Soil, Effective Stress in the Zone of the Capillary Rise

Stresses in a Soil Mass: Normal and Shear Stress along a Plane, The Pole Method of Finding Stresses along a Plane, Mohr-Coulomb Failure Criteria, Determination of Shear Strength Parameters for Soils in the Laboratory, Triaxial Shear Test, Unconfined Compression Test of Saturated Clay, Sensitivity and Thixotropy of Clay.

Lab

Grain size distribution of granular soils (sand). Atterberg limits of cohesive soils (clay). Moisture-density relations of soils (compaction test). Permeability of granular soils (constant head). Unconfined compressive strength of cohesive soil. Direct shear test of soils under consolidated drained conditions

Books Recommended:

1. Beavis, F.C., (1985). Engineering Geology, Blackwell Scientific Publications.
2. Bowles, J.E. (1991). "Physical and Geotechnical Properties of Soils" McGraw-Hill Book Co.
3. Braja Das (2007). Principles of Foundation Engineering, 6th edition, Thomson-Engineering, India.
4. Braja M. Das (2002). Principles of Geotechnical Engineering, fifth Edition, Thomson-Engineering, India.
5. Capper, P.L., Cassive W.E. and Geddes, J.D. (1966). Problems in Engineering Soil, Latest Ed., John Willey & Sons
6. Das, B.M. (1998). "Principles of Geotechnical Engineering" Fourth Edition, PWS Publishing Co.
7. Duncan, N (2006). Engineering Geology and Rock Mechanics, VNU entertainment Media (UK) Ltd.
8. Lambe, T.W., and Whitman, R.V. (1979). "Soil Mechanics" John Wiley & Sons Publishing Co.
9. Neward, N.M (2006). Structural and Geotechnical Mechanics, Muze Incorporation.

GEOL-532 ROCK MECHNICS – I (03 Credit hrs)

Physical and mechanical properties of rocks. Deformation, testing and parameters of intact rocks. Engineering classification of rocks. Description, parameters and measurement of rock discontinuities. Rock mass – description, characterization and classification systems. Rock mass strength criteria.

Lab:

Measurement of porosity and stress- strain curves, point load tests, uniaxial compressive strengths, Brazilian tensile strength test. Special assignment and presentations.

Recommended Books:

1. Attwell P. B. and Farmer I .W. (1976). Principles of Engineering Geology, Chapman & Hall, London.
2. Berkman, D, A. (2001): Field Geologist's Manual. 4th ed. The Australian Institute of Mining and Metallurgy, Victoria, Australia.
3. Brady, B H G and Brown, E T (2004). Rock Mechanics for Underground Mining. 3rd Edition, Springer, Netherlands.
4. E. Hoek & John-Bray (1977), Rock Slope Engineering, Institute of Mining and Metallurgy, L. Rex Printing and Co. China.
5. E.T. Brown (1981), Rock Characterization, Testing and Monitoring, International Society for Rock Mechanics (ISRM), Pergamon Press, Oxford, U.K.
6. Fairhurst, C. (1962), Rock Mechanics, Pergamon Press, Oxford, U.K.
7. Goodman, R E (1980). Introduction to Rock Mechanics, John Wiley and Sons, Toronto, Canada.
8. Hoek, E and Brown, E T (1997). Underground Excavations in Hard Rock, Chapman and Hall, UK.
9. Hoek, E. and Bray, J .W. (1997). Rock Slope Engineering, Chapman and Hall, London.
10. Hudson, J A and Harrison, J P (1997). Engineering Rock Mechanics, An Introduction to the Principles, Pergamon, Elsevier Science, UK.
11. Ian W. Farmer (1983). Engineering behaviour rocks, 2nd Ed., Chapman & Hall London.
12. Price, N.J. (1966). Fault and joint Development in Brittle and Semi-Brittle Rock, Pergamon Press, Oxford, U.K.

13. Weijermars, R (1997). Principles of Rock Mechanics, Alboran Science Publishing, Amsterdam.

GEOL-533 ADVANCE HYDROLOGY (03 Credit hrs)

Fundamental processes in physical hydrology that control movement and storage of water within a watershed or catchment basin. Components of the water balance (precipitation, interception, infiltration, evapotranspiration, runoff, storage) and their variations in space and time. Theoretical and practical approaches to measurement and forecasting of components and their linkages. Special consideration of snowmelt, stream flow, wetlands, and human impacts. Hydrologic Cycle, Weather. Precipitation: intensity, frequency, duration; Point and area estimates of precipitation; rational methods. Hydrologic abstractions. Runoff, storms, conceptual models, unit hydrograph principles, inflow design hydrograph. Stream flow: gauging, stage-discharge. Channel and Reservoir flood routing. Snowmelt: basics of hydrologic modeling; Probability applications and frequency analysis of precipitation and floods. Groundwater flow and water wells.

Lab.

Practical approach to measure precipitation, runoff, Hydrograph, Groundwater flow.

Books Recommended

1. Awan, N.M. (1981), Surface Water Hydrology, National Book Foundation, Islamabad, Pakistan.
2. Bras, Rafael l. (1990), Hydrology: An Introduction to Hydrologic Science, Addison-Wisley, UK.
3. Chow, Ven TE, (1964). Handbook of Applied Hydrology, McGraw Hill Company.
4. Garg, Santosh Kumar, (2002), Hydrology and Water Resources Engineering, Khanna Publishers, India.
5. Kazmann, Raphel G. (1972), Modern Hydrology, Harper and Row New York, USA.
6. Linsley, Ray K., Max Adam Kohler and Joseph, L.H. Paulhus (1975), Hydrology for Engineers, McGraw Hill Publishers.
7. Singh, Vijay P. (1992), Elementary Hydrology, Printice Hall Publishers

SECOND SEMESTER

GEOL-505: RESEARCH METHODOLOGY AND TECHNICAL WRITING (CORE-SUBJECT 03 Credit Hours)

Background and philosophy of research: concept of research, types of research, elements of research. Types of data for research. Various stages of research, research methods and methodology. Research proposal, selection of a research topic and problems, literature survey, reference collection, hypothesis, mode of approach, actual investigation, results and conclusion, presenting an oral scientific seminar, writing a report, research paper and thesis. Layout of a research report PhD thesis/ M.Phil dissertation. Plagiarism and its professional consequences.

GEOL-534 CONSTRUCTION MATERIALS (03 Credit hrs)

Geological aspects of construction materials. Geological and geophysical exploration methods. Quarrying methods for construction materials. Nature of fine and coarse aggregates, their testing and characterization for road and concrete. Classification of soils as construction material. Strength of rocks and concrete mix design. Aggregate and concrete petrography. Alkali Silica reactivity, mechanism, testing and mitigation techniques. Physical properties of clays for brick making. Physical properties and testing of dimension stones. Asphalt as construction material. Aggregate resources of Pakistan.

Lab.

Classification of fine aggregates. Road and concrete aggregate testing. Aggregate and concrete petrography with respect to ASR potential.

Books Recommended

1. Broadhead, G.E. and Hills, J.F. 1990. Aggregates for Bituminous Materials, in Standards for Aggregates, Ed. D.C. Pike, Ellis Horwood, London.
2. Brownell, W.E. 1976. Structural Clay Products, Springer, Berlin, Germany.
3. Dolar, Mantuani, L. 1983. Handbook of Concrete Aggregates, A Petrographic and Technological Evaluation, Noyes, New Jersey.
4. Hobb, D.W. 1988. Alkali-Silica Reaction in concrete. Thomas Telford Ltd, London.
5. McNally, G.M. 1998. Soil and rock construction materials, E & FN Spon, London.
6. Neville, A.M. 1981. Properties of concrete, 3rd Ed. Longman, London
7. Prentice, J.E. 1990. Geology of Construction Materials. Chapman and Hall, London
8. Swamy, R.N., 1992. The Alkali-Silica Reaction in Concrete. Blackie and Son, London.

GEOL-535 ENGINEERING GEOLOGY (03 Credit hrs)

Geological and engineering geological mapping considerations. Topographic maps. Exploratory boring and drilling. Trenches, adits and testpits. Insitu testing and logging. Surface and sub surface sampling. Determination of laboratory parameters. Types of foundations for buildings, bridges, dams etc. Foundation evaluations. Preparation of factual and evaluation reports. Dam design criteria. Problems associated with Dams. Failure criteria strength and design parameters. Types of slope movements and classification. Mechanism of slope failure. Slope geometry, engineering behavior of slope material and drainage conditions. Geological and structural data acquisition. Soil and rock slope stability evaluations. Components of roads and highways. Classification of roads.

Lab.:

Preparation of base maps, from toposheets and satellite image. Finalization of final maps from field maps. Interpretation of field and Laboratory data. Plotting of structural data on stereonets. Slope stability analysis. Data analysis for evaluation of parameters.

Books Recommended:

1. Attewell, P.B. & Farmer, I.W., (2006). Principles of Engineering Geology, John Willey & Sons, New York.

1. Attwell P. B. and Farmer I .W. (1976). Principles of Engineering Geology, Chapman & Hall, London.
2. Beavis, F.C., (1985). Engineering Geology, Blackwell publishers.
3. Bell, F.A.G., (1983). Fundamentals of Engineering? Geology, Butter Worth.
4. Blyth, F.G.H. & De Frietes, M.H., (1960). Geology for Engineers, Butter & Tonner Ltd.
5. Duncan, N (2006). Engineering Geology and Rock Mechanics, VNU entertainment Media (UK) Ltd.
2. Engineering Geology by Beavis, F.C., 1985, Blackwell.
3. Evert Hoek and John Bray (1981). Rock Slope Engineering, Taylor & Francis.
4. Franklin, J.A. & Dusseault, M.B., (1989). Rock Engineering, McGraw Hill.
5. G.B. Giani, (1992). Rock Slope Stability analysis, Brookfield.
6. Geology for Engineers by Blyth, F.G.H. & De Frietes, M.H., 1960, Butter & Tonner Ltd.
7. Goodman, R.E., (1993). Engineering Geology by John Wiley & Sons.
6. J.A. & Dusseault, M.B., (1989). Rock Engineering, Franklin, McGraw Hill.
7. Legget, R.F., (1962). Geology and Engineering, McGraw Hill.
8. Wray, W.K., (1986). Measuring Engineering Properties of Soil, Prentice Hall.

GEOL-536 SOIL MECHNICS-II (03 Credit hrs)

Compressibility of Soil: Fundamentals of Consolidation, One-Dimensional Laboratory Consolidation Test, Void Ratio Pressure Plots, Normally Consolidated and Overconsolidated Clays, Effect of Disturbance on Void Ratio-Pressure Relationship, Influence of Other Factors on e-log p Relationship, Calculation of Settlement due to One-Dimensional Primary Consolidation, Compression Index, Swell Index, Settlement due to Secondary Consolidation, Time Rate of Consolidation, Coefficient of Consolidation.

Slope Stability: Factor of Safety, Stability of Infinite Slopes without Seepage, Stability of Infinite Slopes with Seepage, Finite Slopes, Analysis of Finite Slope with Circularly Cylindrical Failure Surface, Method of Slices.
Stresses in Soil: Types of stresses, Geostatic stress, Induced stress, Vertical stress, Horizontal stress,
Settlements: Influence factors for vertical displacement under flexible area, Consolidation, One dimensional consolidation, Assumption for one- dimension consolidation, Oedometer test, Compressibility characteristics, Compressibility, coefficient of volume, Compression index, Consolidation settlement.
Environmental Geotechnology: Landfill Liners-Overview, Geosynthetics, Geotextiles, Geomembranes, and Geonets, Single Clay Liner and Single Geomembrane Liner Systems, Recent Advances in the Liner Systems for Landfills.
Soil Exploration: Common Methods of Sampling.

LAB:

One-dimensional consolidation properties of soils. Unconsolidated, undrained compressive strength of cohesive soils in triaxial compression.

Recommended Books:

1. Beavis, F.C., (1985), Engineering Geology, Blackwell Scientific Publications.
2. Bolton, Malcolm (1991). A Guide to Soil Mechanics, M.D. & K.Bolton.
3. Bowles, J.E. (1991). "Physical and Geotechnical Properties of Soils" McGraw-Hill Book Co.
4. Braja Das, (2007). Principles of Foundation Engineering, sixth edition, Thomson, Toronto, Canada.
5. Braja M. Das, (2002). Principles of Geotechnical Engineering, fifth Edition, Thomson.
6. Capper, P.L. & Cassive W.E. & Geddes, J.D., (1966), Problems in Engineering Soil, Latest Ed., John Willey & Sons
7. Das, B.M. (1998). "Principles of Geotechnical Engineering" Fourth Edition, PWS Publishing Co.
8. Duncan, N (1968). Engineering Geology and Rock Mechanics, Leonar Hill.
9. Jumikis, Alfred R., (1962). Soil Mechanics, Princeton, New Jersey: D. Van Nos- trand Company, Inc.
10. Lambe, T.W., and Whitman, R.V. (1979). "Soil Mechanics" John Wiley Publishing Co.
11. Newward, N.M. (1972). Structural and Geotechnical Mechanics , Prentice Hall.
12. Taylor, Donald W., (1949). Fundamentals of Soil Mechanics, John Willey & Sons.
13. Terzaghi, Karl, Soil Mechanics in Engineering Practice by
14. Tuma, Jan J. and M. Abdel Haddy (1977). Engineering Soil Mechanics, Prentice Hall.

GEOL-537 ROCK MECHNICS – II (03 Credit hrs)

Underground excavations and excavation methods in hard and soft rocks, framework of regional ground stresses, methods of in-situ stress measurements, stress distribution around underground excavations. Kinematic and analytical analysis of subsurface geotechnical data. Support design for underground excavations. Introduction and application of numerical methods in rock mechanics: FEM, BEM, DEM etc.

Lab.

Stability analysis for rock excavations using numerical tools, special assignments and presentations.

Recommended Books:

1. Bieniawski, Z.T.(1984). Rock Mechanics Design in Mining and Tunnelling. Balkema, Rotterdam.
2. Bieniawski, Z.T.(1989). Engineering Rock Mass Classifications. Wiley, New York.
3. Brady, B H G and Brown, E T (2004). Rock Mechanics for Underground Mining. 3rd Edition, Springer, Netherlands.
4. Goodman, R E (1980). Introduction to Rock Mechanics, John Wiley and Sons, Toronto, Canada.
5. Hoek, E and Bray, J W (1997). Rock Slope Engineering, Chapman and Hall, London.

6. Hoek, E and Brown, E T (1997). Underground Excavations in Hard Rock, Chapman and Hall, UK.
7. Hoek, E, Kaiser, P K and Bawden, W F (1995). Support of Underground Excavations in Hard Rock. Balkema, Rotterdam.
8. Hudson, J A and Harrison, J P (1997). Engineering Rock Mechanics, An Introduction to the Principles, Pergamon, Elsevier Science, UK.
9. Kirkaldie, L. (1988). Rock Classification for Engineering Purposes. American Society for Testing and Materials (ASTM), Philadelphia.
10. Singh, B and Goel, R K (1999). Rock Mass Classification- A Practical Approach in Civil Engineering. Elsevier, Oxford, UK.
11. Weijermars, R (1997). Principles of Rock Mechanics, Alboran Science Publishing, Amsterdam.

GEOL-538 HYDROGEOLOGY AND GROUNDWATER MODELLING (03 Credit hrs)

Fundamental physics and properties of groundwater flow in porous geologic material, develops an intuitive, problem-solving approach to hydrogeologic problems. Topics include: groundwater flow equations, flow nets, aquifer pumping, contaminant transport processes, two-phase flow, and dense non-aqueous phase liquids. Computer application will be emphasized. Review of hydrologic and hydraulic modeling concepts, inter-linkages between flows and water levels in natural water bodies; Data requirements and sources for various modeling problems using different models e.g. MODFLOW, ARCHYDROGEOLOGY.

Lab.
Hands on Practice on Mod-flow, Arc GIS for Groundwater Modeling.

Books Recommended

1. Driscoll, F.G., (1989). Groundwater and Wells, Johnson Filtration System Inc. St. Paul.
2. Todd, D.K. (1980). Groundwater Hydrology, John Willey and Sons.
3. R.A. & Cherry, J.A., (1979). Groundwater, Freeze A Simo and Schuster Company.
4. Fetter, W. (1988). Applied Hydrogeology, Merril.
5. Price, M. (1995), Introducing Grounds water by Allen and Unwin.
6. Geofluids. H. (2003). Introduction to Hydrogeology, Blackwell Synergy.
7. Braissington, R., (1998). Field Hydrogeology, John Wiley and Sons.
8. Walton, W.C. (1970). Groundwater Resources Evaluation., McGraw Hill Ltd.
9. Driscall, F.G. (1989). Groundwater and Wells, Johnson Filtration System Inc. St. Paul.