

University of Mumbai



No. AAMS(UG)/91 of 2021-22

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, the Head of the University Departments and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to the syllabus uploaded by Academic Authority Meetings and Services which was accepted by the Academic Council at its meeting held on 27th February, 2013 vide item No. 4.65 relating to the revise syllabus of M.Sc. Geology – Sem III & IV (CBCGS).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Geology at its online meeting held on 9th June, 2021 vide Item No. 1 and subsequently passed by the Board of Deans at its online meeting held on 28th June, 2021 vide item No. 8.29 (R) have been accepted by the Academic Council at its meeting held on 29th June, 2021 vide item No. 8.29 (R) and that in accordance therewith, the revised syllabus as per the (CBCS) for the M.Sc. Geology – Sem IV has been brought into force with effect from the academic year 2021-22 accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI- 400 032
30th September, 2021


(Dr. B.N. Gaikwad)
I/c REGISTRAR

To

The Principals of the Affiliated Colleges the Head of the University Departments and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/8.29 (R) 29/06/2021

No. AAMS(UG)/91 -A of 2021-22

MUMBAI-400 032

30th September, 2021

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology ,
- 2) The Chairman, Ad-hoc Board of Studies in Geology.
- 3) The Director, Board of Examinations and Evaluation.
- 4) The Director, Board of Students Development,
- 5) The Co-ordinator, University Computerization Centre,


(Dr. B.N. Gaikwad)
I/c REGISTRAR

Copy to :-

- 1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
- 2. The Deputy Registrar, College Affiliations & Development Department (CAD),**
- 3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
- 4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
- 5. The Deputy Registrar, Executive Authorities Section (EA),**
- 6. The Deputy Registrar, PRO, Fort, (Publication Section),**
- 7. The Deputy Registrar, (Special Cell),**
- 8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
- 9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

- 1. P.A to Hon'ble Vice-Chancellor,**
- 2. P.A Pro-Vice-Chancellor,**
- 3. P.A to Registrar,**
- 4. All Deans of all Faculties,**
- 5. P.A to Finance & Account Officers, (F.& A.O),**
- 6. P.A to Director, Board of Examinations and Evaluation,**
- 7. P.A to Director, Innovation, Incubation and Linkages,**
- 8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
- 9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
- 10. The Director of Board of Student Development,**
- 11. The Director, Department of Students Welfare (DSD),**
- 12. All Deputy Registrar, Examination House,**
- 13. The Deputy Registrars, Finance & Accounts Section,**
- 14. The Assistant Registrar, Administrative sub-Campus Thane,**
- 15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
- 16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
- 17. The Assistant Registrar, Constituent Colleges Unit,**
- 18. BUCTU,**
- 19. The Receptionist,**
- 20. The Telephone Operator,**
- 21. The Secretary MUASA**

for information.

AC – 29/06/2021
Item No. – 8.29 (R)

UNIVERSITY OF MUMBAI



Revised Syllabus for M.Sc. (Geology)

Semester: IV

(As per the Choice Based Credit System with effect from the academic year
2021-22)

Syllabus

for IVth Semester Courses in

M.Sc. (Geology)

Courses:

PSGE401 – Oceanography and Atmospheric Science

PSGE402– Dissertation

PSGE403- Elective-1

- a) Engineering Geology
- b) Economic and Mining Geology

PSGE404 – Elective-2

- a) Quaternary Geology
- b) Soil Science

Practical Course:

(Practical pertinent to the above-mentioned theory courses)

M.Sc-II Geology Course: PSGE401

Title: Oceanography and Atmospheric Science

Learning Objectives: To get an understanding and insight of oceanography, its domains along with fundamentals of atmospheric processes and their bearing on past and present climate.

Number of lectures: 60

Unit 1: (15 lectures)

History of development of oceanography; Sampling of modern ocean biogenic flux including sediment trap sampling; Methods of measuring properties of sea water; Temperature and salinity distribution (horizontal and vertical) in ocean waters; Dissolved gases in sea water, factors affecting the concentration of gases in sea water; Carbon dioxide equilibria, precipitation and dissolution of carbonates; Biological - chemical - physical interactions in the oceans; Oxygen minimum layer in the ocean. Scientific ocean drilling and its major accomplishments

Unit 2: (15 lectures)

Ocean processes; Concept of mixed layer, thermocline, pycnocline and halocline. Coriolis force and Ekman spiral, upwelling, El Niño and La Nina, Ocean circulation- surface circulation; deep ocean circulation (concept of thermohaline circulation, formation of bottom waters, water masses of the world oceans, oceanic sediments). Collecting meteorological data in oceans; interpreting the data & metadata and its utility in study of oceans and the overall earth climate. Study of various aspects of meteorology for devising various models in climate prediction. Study of anthropogenic activities and analysis of the meteorological data & metadata for better and practical studies of oceans.

Unit 3: (15 lectures)

Introduction to atmospheric processes

Basic concept of different layers of our atmosphere, their coupling and composition. Lapse rate, hydrostatic equation. Basic concepts of Thermodynamics, basic concept of radiation, solar parameters and solar constant. Composition of stratosphere, Ozone hole over Antarctica and the different theories, atmospheric response to different pollutants. Different calamities and Recent climate change.

Unit 4: (15 lectures)

General climatology

Introduction and fundamental principles of climatology, the climate system: controls on climate. global climate classification, earth-sun relation, coastal effect on climate, orographic effect on climate, different climate zones, trends of climate and its variability. Indian climatology: seasonal pattern of different weather elements: western disturbances, Kalbaishaki (pre-monsoon local severe storms), monsoon(SW & NE), tropical cyclones, heat waves and cold waves, greenhouse warming, interannual variability of climate & its effect on biosphere, different climate methods. Regional distribution and seasonal variation of

cloud, precipitation and fog. Climatic classification, climatic regions of the world, climate in the equatorial, tropical, subtropical and Polar Regions

PSGE401 Practical

Oceanography

Depth biotopes; Thermocline and deep surface water of the modern oceans;
Quantitative study of planktic foraminifera and their interpretation in relation to paleoclimatology.

Analysis of variation of surface temperature, Trend of rainfall, Trend of lightning activity over Mumbai. Cloud characteristics using remote sensing.

Analysis of wind data- calculation of absolute vorticity, geostrophic wind, gradient wind and thermal wind. Working of meteorological instruments. Air quality analysis.

List of Recommended Reference Books

1. Pinet, Paul R. (2006): Introduction to Oceanography, Jones & Bartlett Learning.
2. Grant Gross, M. (1995): Oceanography; A view of the Earth (7th Ed.), Prentice Hall.
3. Garrison, T. (2007): Oceanography: an invitation to marine sciences, Cengage Learning.
4. Bradley, R.S. (Ed.) (1999): Paleoclimatology (2nd Ed.), Elsevier.
5. Marcel, C.H. and Vernal, A.D. (Ed.) (2007): Proxies in Late Cenozoic Paleoceanography, Elsevier.
6. Hartmann, D. L. (2015). Global physical climatology (Vol. 103). Newnes.
7. Robinson, P. J., & Henderson-Sellers, A. (2014). Contemporary climatology. Routledge.
8. Chang, C. P. (2011). The global monsoon system: research and forecast (Vol. 5). World Scientific.
9. Goodess, C. M., Palutikof, J. P., & Davies, T. D. (1992). The nature and causes of climate change: assessing the long-term future. Belhaven Press.

M.Sc-II Geology Course: PSGE402

DISSERTATION (Topic for dissertation will be assigned during the 3rd semester.)

Evaluation of Dissertation: Student is required to submit two progress reports and the final thesis.

Total marks allotted for dissertation-150

Fieldwork of at least 15 days is mandatory for the dissertation.

Progress report 1-Reference work - pre-field / pre lab literature survey, preparation of field material (toposheet, satellite imagery etc.)- Viva will be conducted by dissertation guide and one examiner.

Progress report 2: Field work, Lab work, Geological mapping, Sample collection, field diary. Viva will be conducted by dissertation guide and one examiner.

End Semester Examination: Dissertation Report and Open Viva

Total marks are distributed as 30 marks for each progress report and sixty marks for the final thesis (60 marks) + viva (30 marks) making a total of 150 marks.

M.Sc-II Geology Course: PSGE403

Elective-1

a) Title: Engineering Geology

Learning Objectives: To understand the engineering properties of rocks. Detailed study of various geological and geotechnical investigations for various civil engineering projects.

Number of lectures: 60

Unit 1: (15 lectures)

Rock and soil mechanics

Techniques of determining properties of rocks and soil:

Specific Gravity

Porosity

Sorption

Compressive Strength

Tensile Strength

Elasticity of Rocks

Residual Stress and Shear Stress in Rocks.

Soil mechanics

Rocks as construction material

Unit 2: (15 lectures)

Geological and Geotechnical investigations for Civil Engineering Projects:

Geotechnical investigations- Sounding, Drilling equipment and methods, Wash borings, core samples, borehole logs.

Building site exploration- Types of foundations, load tests, groundwater problem. Commercial, residential and industrial building site investigation

Bridges and pavements- Abutments and piers, foundations, cofferdams, Caissons, rigid and flexible pavement. Site exploration.

Unit 3: (15 lectures)

Tunnels and shoreline engineering

Tunnels- Terminology, technical classification, roof bolting, arching, effect of bedding orientation on tunnels. Gases and water in tunnels, geothermal gradient. Methods of tunnel excavation and site exploration

Shoreline engineering- Beach and shorelines, construction of shore cliffs and steep banks, Littoral barriers, harbour location, sedimentation in harbours and jetties.

Unit 4: (15 lectures)

Dams, reservoirs and landslides

Dams and Reservoirs: Geological conditions for the selection of dam and reservoir sites.

Terminology associated with dams. Types of dams: Masonary Dams (Gravity, Buttress and Arch types), Earthen dams. Types of spillways. Case studies of dam construction and failures.

Landslides- Causes, types and prevention of landslides.

PSGE403(a) Practical Engineering Geology

- Correlation of borehole data
- Determining uniaxial compressive strength of rock
- Equal-area net- Determining slope stability and rotation problems.
Numerical problems pertaining to topics in the theory.
Geotechnical investigations for the construction site (problems, maps etc.).

List of Recommended Reference Books

1. Waltham, T. (2009): Foundations of engineering geology, 3rd edition, CRC press
2. Vallejo, L.G, Mercedes, F., Freitas, M. (2011): Geological Engineering, 1st edition, CRC press
3. West, T.R (2010): Geology applied in Engineering, Waveland Pr Inc; 1 edition
4. Narayanswami S.B.S. (2000), Engineering Geology, Dhanpat Rai & Co, India.
5. Legget F. R and Hatheway A.W. (1988), Geology and Engineering., 3rd ed. McGraw-Hill.
6. Gupte R.B. (1992), A Textbook of Engineering Geology.2nd ed. Pune Vidyarthi Griha Prakashan.
7. Krynine D.P. And Judd W.R (2003), Principles of Engineering Geology and Geotechniques, CBS Publishers.
8. Wahlstrom E.E. (1974), Dams, Dam Foundations and Reservoir Sites. Elsevier Scientific.
9. Dunn I.S., Anderson L.R and Kiefer F.W. (1980), Fundamentals of Geotechnical Analysis, John Wiley.
10. Maslov N.N. (1987), Basic Engineering Geology and Soil Mechanics. Mir Publishers.
11. Gokhale K.V.G.K and Rao D.M. (1981), Experiments in Engineering Geology. Tata McGraw-Hill

M.Sc-II Geology Course: PSGE403

Elective-1

b) Title: Economic and Mining Geology

Learning Objectives: To understand the various processes of ore formation, distribution and various aspects of mining with special reference to India.

Number of lectures: 60

Unit 1: (15 lectures)

Origin of ore deposits: Concept of ore bearing fluids, their origin and migration; Processes of formation of ore deposits metasomatic, hydrothermal and supergene enrichment; Controls of ore localization; Ore deposits and plate tectonics. Mineralogy, classification and genesis of ore deposits associated with mafic-ultramafic rocks; Ores of felsic-silicic rocks; Ores of sedimentary affiliation; Ores of metamorphic affiliation; Placer and residual concentration deposits.

Unit 2: (15 lectures)

Occurrences of ore minerals in India: Study of ore minerals related to the following metals with special reference to their mineralogy, genesis, specification, uses and distribution in India: Iron, Manganese, Base Metals, Chromium, Gold, Tin and Tungsten. Study of important Indian ore deposits with reference to their geology, stratigraphy and reserves; A few case studies of occurrence of economic mineral deposits from provinces other than Indian sub-continent.

Unit 3: (15 lectures)

Methods of mining: Subsidence and the support of mine excavation; timber treatment; methods of breaking rocks; drilling blast holes; explosives used in mining; blasting practices; shaft sinking; mine drainage; ventilation; illumination.

Alluvial, open-pit and underground mining methods; drifting; cross cutting; winzings; stoping; room and pillaring; top-slicing; sub-level caving and block caving; ocean bottom mining, mine organization and operation; mine hazards.

Unit 4: (15 lectures)

Evaluation of mineral deposits: Factors in evaluating a mineral deposit; mine examination; theory and methods of sampling; sampling calculations; recoverable values
Cost of mining; future costs and profits; life of mine; present value of mine and its determination by compound interest and Hoskold formula methods; amortisation; calculations pertaining to valuation of mines of uniform and non-uniform annual income; sale of mineral products; metal prices and mine valuation; valuation of prospects: developed mines and working mines; valuation report

PSGE403(b) Practical

Identification of important ore minerals in hand specimens.

Ore microscopy- textures, microstructures, optical properties of ores.

Determination and evaluation of ores in mines; different sampling calculations; recoverable values; cost of mining; future cost and profits; life of mine; determination of present value of mines; cross section of mines with the help of available data.

List of Recommended Reference Books

1. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
2. Jensen M.R. and Bateman A.M. (1981), Economic mineral deposits, John Wiley & Sons.
3. Craig, J.R. and Vaughan, D.J. (1994): Ore Microscopy and Petrography.
4. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
5. Wolf, K.H. (1976-1981): Handbook of Stratabound and Stratiform Ore deposits, Elsevier.
6. Mookherjee, A. (1999): Ore Genesis- A Holistic Approach., Allied Publishers.
7. Abzalov, M. (2016). Applied mining geology (Vol. 12). Cham: Springer International Publishing.
8. Pivnyak, G., Bondarenko, V., Kovalevs' ka, I., & Illiashov, M. (Eds.). (2013). Mining of mineral deposits. CRC Press.

M.Sc-II Geology Course: PSGE404

Elective-2

a) Title: Quaternary Geology

Learning Objectives: Understanding the geological history of Quaternary Period. Glacial behaviour and evidence for glaciation over the last 2.6 million years of Earth's history. Global sea level, climatic changes and continental sedimentation during Quaternary.

Number of lectures: 60

Unit-1: Introduction to Quaternary geology (15 lectures)

Definition and subdivision of the Quaternary period. Pleistocene-Holocene Boundary, Meghalayan Age and its importance. Stable Isotopes and their importance. The astronomical theory of climatic variations. Glacial-Interglacial cycles, marine isotopic stages in Quaternary. Variations in greenhouse gases. Fluctuations in sea level. Cycles with high frequency and short events. Climatic characteristics of the last glacial-interglacial transition and its climato-stratigraphic subdivision.

Unit 2- Quaternary continental sedimentary records (15 lectures)

Environmental implications of continental sediments- Lacustrine sediments, deformation of lacustrine sediments- varves and rhythmites. Sampling techniques of lake and marsh deposits. Quaternary Fluvial sedimentary successions and landforms- Slope deposits. Mass movements. Debris slopes and slope breccias. Identification of a landslide. Aeolian sediments and their importance in Quaternary- Indian Examples. Importance of Soils and paleosols in Quaternary Geology. Quaternary stratigraphy and Paleontology of important Quaternary Basins of India.

Unit 3- Quaternary glacial records (15 lectures)

Glacial landforms and processes. Classification and representation of deposits-glacial till and diamictites. Thermal classification of glaciers. Glacial flow. Erosion and deposition by glaciers. Types of glacial sediments. Deglaciation of a glaciated valley and fluvio-glacial deposition. Periglacial environment and wind. Permafrost. Loess: stratigraphic importance. Importance of glacial sediments and glacial ice in Quaternary stratigraphy.

Unit 4- Dating techniques (15 lectures)

Radiocarbon and other dating methods: production and incorporation of ^{14}C in the biosphere, contamination, measurement by count, standard deviation, dendrochronological calibration.

Selection of material for ^{14}C dating. ^{14}C dating material in soils.

Thermoluminescence, OSL, Rb-Sr, K-Ar, U-Pb and Sm-Nd methods of dating used in the Quaternary.

Biological and paleoclimate archives. Palynology, plant macro-remains and their use in the palaeoenvironment reconstruction. Quaternary vertebrate fossils and human evolution in context of India.

PSGE404(a) Practical

Use of stable isotopes of Oxygen and Carbon in stratigraphy- understanding 'Delta' notation, standards, and numerical problems based on stable isotopes.

Numerical problems on Rb-Sr, K-Ar and U-Pb Method- isochrons, Concordia and Discordia construction.

Understanding the Milankovic cycles and some proxy records (case studies)

Identification and morphology of important vertebrate fossils. Microscopic and hand specimen study of calcretes.

OSL sampling techniques.

List of Recommended Reference Books

- 1) Dawson, A. G. (1992). Ice age earth: late quaternary geology and climate. Psychology Press.
- 2) Riser, J. A. M (2001). Quaternary geology and the environment, Springer Berlin Heidelberg, Dec 1, 2001 - Science – 290p
- 3) Lowe, J. J., & Walker, M. (2014). Reconstructing quaternary environments. Routledge.
- 4) Tiwari, M. P. and Mohabey, D. M (1999). Quaternary of India, Gondwana Geological Magazine Spec. Vol.4, Gondwana Geological Society, Nagpur, 1999, 409p.
- 5) Siebert, M. J. (2001). Ice sheets and late Quaternary environmental change. Hoboken, NJ: John Wiley.
- 6) Grapes, R. H., Grigelis, A., & Oldroyd, D. (Eds.). (2008). History of geomorphology and Quaternary geology. Geological Society of London.
- 7) Catt, J. A. (1986). Soils and Quaternary geology: a handbook for field scientists. Oxford University Press.
- 8) Ramakrishnan, M., & Vaidyanadhan, R. (2010). Geology of India (vol. 2). Geological Society of India Publications, 2(1).
- 9) Catto, N. (2019). Handbook of Luminescence Dating. Geoscience Canada: Journal of the Geological Association of Canada/Geoscience Canada: journal de l'Association Géologique du Canada, 46(4), 195-196.
- 10) Michener, R., & Lajtha, K. (Eds.). (2008). Stable isotopes in ecology and environmental science. John Wiley & Sons.
- 11) Faure, G., & Mensing, T. M. (2005). Isotopes: Principles and applications. John Wiley & Sons, Inc.

M.Sc-II Geology Course: PSGE404

Elective-2

b) Soil Science

Learning Objectives: To develop an understanding and knowledge of the basic and applied chemical, physical, and biological concepts in soil. Understanding origin, classification, and distribution of soils; their relationship to people and food production, management and conservation of soils and the environmental impact of soil use.

Number of lectures: 60

Unit-1: Fundamental concepts of soil (15 lectures)

Concept of soil, components of soil, soil profile, pedogenic processes; Classification of soil, mineral and chemical composition of soils, mineral stability during weathering; Soil organic matter form and function; A brief introduction to methods of soil conservation.

Unit 2- Soil fabric (15 lectures)

Fabric analysis - Color, size and shape, grade scale, methods of grain size analysis, presentation of data, analysis and field grading; Concepts of structure and fabric: Soil fabric, soil structure, soil texture; Peds and pedality, size and shape of peds, primary, secondary and tertiary structures and their interpretation; Voids - concepts, size, shape, arrangement and morphological classification.

Unit 3- Paleosols and their importance (15 lectures)

Paleosols - Field recognition, description, origin; Paleosols in stratigraphic records; Significance of paleosol study; Paleosols and human evolution. Calcrete and ferricrete- definition, classification, formation, relation to soil profile, macro features and micromorphology (petrography); Significance of calcretes; Laterite - characteristics, genesis, Indian occurrences.

Unit 4- Soil Survey and management (15 lectures)

Soil survey and its types; soil survey techniques-conventional and modern; soil series characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, techniques for generation of soil maps. Landform-soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigation classification; land evaluation and land-use type (LUT)-concept and application; approaches for aging soils and landscapes in the framework of agro-ecosystem.

PSGE404(b) Practical

Collection of Representative Soil Sample, its processing and handling in laboratory.
Simultaneous Measurement of Bulk Density and Water Content- Soil moisture determination.
Measuring Soil pH, electrical conductivity, organic carbon, soil profile studies
Soil maps, landuse-landcover maps using GIS. Soil Survey techniques.

Soil porosity and permeability determination, Geotechnical properties of soil.
Soil fabric analysis.
Introduction to GIS softwares. Digital Soil Survey Maps.

List of Recommended Reference Books

- 1) Eash, N. S., Sauer, T. J., O'Dell, D., & Odoi, E. (2015). Soil science simplified. John Wiley & Sons.
- 2) Troeh, F. R., & Thompson, L. M. (2005). Soils and soil fertility (Vol. 489). New York, USA: Blackwell.
- 3) Foth, H. D. (1978). Fundamentals of soil science. Soil Science, 125(4).
- 4) Schaetzl, R. J., & Thompson, M. L. (2015). Soils. Cambridge university press.
- 5) Gerrard, A. J. (1981). Soils and landforms. An integration of geomorphology and pedology. George Allen & Unwin (Publishers) Ltd.
- 6) Ashman, M., & Puri, G. (2013). Essential soil science: a clear and concise introduction to soil science. John Wiley & Sons.
- 7) Catt, J. A. (1986). Soils and Quaternary geology: a handbook for field scientists. Oxford University Press.
- 8) Retallack, G. J. (2008). Soils of the past: an introduction to paleopedology. John Wiley & Sons.
- 9) Foth, H. D., Withee, L. V., Jacobs, H. S., & Thien, S. J. (1980). Laboratory manual for introductory soil science. Laboratory manual for introductory soil science. (Ed. 5).
- 10) Moorberg, C. J., & Crouse, D. A. (2017). An open-source laboratory manual for introductory, undergraduate soil science courses. Natural Sciences Education, 46(1).