Postgraduate Course M. Sc Geology Syllabus

Learning Outcome Based Curriculum Framework (LOCF)

(Under CBCS)

For Affiliated Colleges
Manonmaniam Sundaranar University
Common Course Structure for M.Sc., GEOLOGY – 2023-2024

Manonmaniam Sundaranar University
Tirunelveli- 627012

2023-2024

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM

FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc. Geology**
Programme Code	**2511**
Duration	**PG - 2 years**
Programme Outcomes (POs)	**PO1: Problem Solving Skill**: Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO9: Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme	**PSO1 – Placement**

Specific Outcomes (PSOs)	To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that complies with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

CREDIT DISTRIBUTION FOR M.Sc., GEOLOGY COURSE

	SUBJECT	C/E/SEC	Credits	Hours	Marks		
					CIA	EXT	Total
SEMESTER I							
1	Physical Geology and Geomorphology	C	5	7	25	75	100
2	Mineralogy and Instrumentation Techniques	C	5	7	25	75	100
3	**Practical:** Mineralogy and Instrumentation Techniques & Paleontology	C	4	6	50	50	100
4	Stratigraphy of India and its Application (Mandatory)	E	3	5	25	75	100
5	Recent Trends in Paleontology/ Urban Geology (Optional)	E	3	5	25	75	100
	Total		**20**	**30**			
SEMESTER II							
1	Structural Geology and Geotectonics	C	5	6	25	75	100
2	Applied Petrology	C	5	6	25	75	100
3	**Practical:** Structural Geology and Geotectonics and Petrology	C	4	6	50	50	100
4	Elective Paper III – Applied Remote Sensing and GIS (Mandatory)	E	3	4	25	75	100
5	Environmental Earth Science/ Isotope Geology (Optional)	E	3	4	25	75	100
6	Oceanography and Climatology	SEC	2	4	25	75	100
	Total		**22**	**30**			
SEMESTER III							
1	Economic Geology	C	5	6	25	75	100
2	Geophysics	C	5	5	25	75	100
3	Hydrogeology	C	5	5	25	75	100
4	**Practical:** Economic geology, Geophysics and Hydrogeology	C	4	6	50	50	100
5	Disaster Management / Medical Geology	E	3	4	25	75	100
6	Research Methodology	SEC	2	4	25	75	100
7	Internship/Industrial visit/Field visit		2	-	50	50	100
	Total		**26**	**30**			
SEMESTER IV							
1	Engineering and Mining Geology	C	5	6	25	75	100
2	**Practical:** Engineering and Mining Geology	C	5	6	50	50	100
3	Geochemistry/ Petroleum Exploration and Mud Logging	E	3	4	25	75	100
4	**Practical:** Geological Field Mapping-	SEC	2	4	50	50	100

	Report submission and viva voce						
5	Project with Viva Voce	C	5	10	50	50	100
6	**Extension activity** – Geological long Field Visit		3	-	50	50	100
	Total		**23**	**30**			
Grand Total			**91**				

C-core **E**-Elective **SEC**-Skill enhancement course

MANDATORY REQUIREMENTS FOR M.Sc. GEOLOGY PROGRAMME

1. **Geological Mapping** will be conducted in an area determined by the Professor-in-charge for the duration of 10 days for I M.Sc Geology students together. Each student have to submit his/her Geological Mapping report separately during II M.Sc final practical exams and there will be VIVA VOCE during Practical Exam. Internal 50 marks and External 50 marks evaluated by external examiner.

2. **Short field trip**: Students have to complete at least two short field trips as determined by the Professor in- charge during First and Second year. A report on the short field trip is to be submitted by the individuals at the end of Third semester practical examinations. There will be VIVA VOCE during Practical Exam. Internal 50 marks and External 50 marks evaluated by external examiner.

3. **Industries or In-plant Training**: Students have to undergo industrial training in any of the industries or implant/professional training in any of the industries, mining or institutes related to geosciences during first year summer holidays or third semester, in the form of groups/ individual. A report on the industrial training is to be submitted at the end of the third semester during the Practical examination. There will be a VIVA VOCE on it. Internal 50 marks and External 50 marks evaluated by external examiner.

4. **Geological Long Field Trip**: II M.Sc., Geology students have to undertake long field trip of duration of about three weeks to places of geological interest as determined by the Professor-in-charge. Submission of separate field report along with the specimens collected at the end of Second Year during the Practical examination is mandatory. There will be VIVA VOCE during Practical Exam. Internal 50 marks and External 50 marks evaluated by external examiner.

5. **Dissertation**: Students have to carry out a research project. The problem, area and topic will be determined by the Professor-in-charge during the course of study. Each student shall submit a dissertation at the end of second year course during the practical examination. There will be a VIVA VOCE during dissertation Practical Exam. Internal 50 marks and External 50 marks evaluated by external examiner.

Semester-III

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Economic Geology	Core	Y	-	-	-	5	6	25	75	100

- To provide knowledge on economically relevant minerals and metals
- To explain the Ore genesis responsible for the economic deposits
- To provide practical knowledge on the minerals and metals
- Detail on the methods applied for mineral exploration
- To summarise the radioactive mineral deposits

	Details	No. of Hours	Course Objectives
Unit I	**Ore Genesis**. Ore deposits and ore minerals. Magmatic processes of mineralization. Porphyry, skarn and hydrothermal mineralization. Fluid inclusion studies, sedimentary, supergene enrichment, placer. Mineralisation associated with – (i) ultramafic, mafic and acidic rocks (ii) greenstone belts (iii) komatiites, anorthosites and kimberlites and (iv) submarine volcanism. Magma related mineralization through geological time. Stratiform and stratabound ores. Ores and metamorphism – cause and effect relations. Metallogeny and mineral belts. SedEx deposits.	18	CO1
Unit II	**Mineral Exploration**. Principles of mineral prospecting and exploration - conceptualization, methodology and stages; sampling, subsurface sampling including pitting, trenching and drilling, core and non-core drilling, planning of bore holes and location of bore holes on ground. Core logging, geochemical exploration- nature of samples anomaly, strength of anomaly and controlling factors, coefficient of aqueous migration.	18	CO2
Unit III	**Mineralogy and geochemistry of radioactive minerals.** Origin and Mineralogy and geochemistry of radioactive minerals. Instrumental techniques of detection and measurement of radioactivity. Radioactive methods for prospecting and assaying of mineral deposits. Distribution of radioactive minerals in India. Radioactive methods in petroleum exploration — well logging techniques. Nuclear waste disposal — geological constraints.	18	CO2
Unit IV	**Coal and petroleum Geology**. Coal and its properties: Different varieties and ranks of coal. Origin of coal. Coalification process and its causes. Fundamentals of coal petrology. Origin, migration and entrapment of natural hydrocarbons. Characters of source and reservoir rocks.	18	CO2

	Structural, stratigraphic and mixed traps. Techniques of exploration. Structural, stratigraphic and mixed traps. Techniques of exploration. Methods of petroleum exploration. Petroliferous basins of India.		
Unit V	**Industrial Geology**. Identification and description of ore and industrial minerals. Geological studies in Coal industries; Petroleum industries; Geological investigation in mining industries. Need of Geologist in industrial sectors. Role of geologist in NLC, ONGC, GSI, WIHG, NIO, NGRI, PRL, RRL, Soil Survey of India, BSIP, Archaeological survey of India.	18	CO2
	Text Books		
1	Banerjee, P. K. and Ghosh, S. (1997) Elements of Prospecting for Non-Fuel Mineral Deposits. Allied Publishers Ltd., New Delhi.		
2	Chatterjee, K. K. (1993) An Introduction to Mineral Economics. Wiley Eastern Ltd., New Delhi.		
3	Krishnasamy S, India's Mineral Resources, Oxford & IBH. Delhi(1988)		
4	Sharma N.L&R.K.Sinha. Mineral Economics, Oxford & IBH. Delhi(1985)		
5	Prasad U, Economic Mineral Deposits, CBS. Delhi (2003)		
6	Krishnaswamy, S. (1979) India's Mineral Resources. Oxford-IBH Publishers, New Delhi.		
7	Bateman, A. M. and Jensen, M. L. (1981) Economic Mineral Deposits. John Wiley & Sons, New York		
8	Industrial Minerals , Sinha,R.K,(1986), Oxford 7 IBH Pub. Co., New Delhi.		
9	Craig,R.C& D.V. Vaughan. Ore Microscopy and Ore Petrography. Wiley. New York.(1985)		
10	Aiyengar, N.K.N, Minerals of Madras, Dept.of Industries &Commerce. Guindy, Madras, (1964).		

Web Resources	
1.	https://www.britannica.com/topic/economic-geology
2.	https://en.m.wikipedia.org/wiki/supergene-(geology)
3.	https://energymining.sa.gov.au/minerals/mineral-commodities
4.	https://www.slideshare.net/mobile/monokaonaBoruah/magmatic-deposits-economic-geology
5.	https://link.spring.com/

Course outcome:

CO1: Students will have the knowledge and skills to recognise common ore minerals in hand samples and under the microscope.
CO2: Demonstrate familiarity with a wide range of mineral deposits, including recognising the overall geometry, zonation and alteration patterns associated with specific classes of metallic mineral deposits,
CO3: To get awareness on geochemistry of radioactive minerals
CO4: Fundamentals of coal petrology, Gain knowledge on the Origin, migration and entrapment of natural hydrocarbons
CO5: Student learns more knowledge on industrial aspects in geological studies.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	2	3	3	3	2	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	2	2	3	2
CO 4	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	2	3	3	2	3	3	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Geophysics	Core	Y	-	-	-	5	5	25	75	100

Course Objectives	
LO1	Student will able to apply geophysical methods for exploring hidden ore minerals, ground water, oil and natural gas resources.
LO2	Explain the principles behind different geophysical surveying techniques.
LO3	Process, analyze and interpret gravitational, magnetic and electromagnetic surveying data.
LO4	Understand the earth subsurface using electrical resistivity.
LO5	Describes the subsurface of the Earth in physical terms – density, electrical resistivity, magnetism, conductivity, and heat flow.

UNIT	Details	No. of Hours	Course Objective
I	Introduction – Physical basis of geophysical exploration, various surface and sub-surface methods and their classification. Physical properties of rocks and minerals exploited in exploration and factors that control them. Geophysical anomaly, Radioactivity of rocks and ores, radioactive minerals and ores. Radiation measuring devices – Ionization chambers, gas filled (Geiger Müller) counters, scintillation counters, radiometers and γ ray spectrometers. Field radiometric methods – Air-borne surveys, automobile surveys, foot surveys. Processing and interpretation of field data. Application of radiometric methods.	15	CO1
II	Gravity Prospecting: Gravity prospecting – Principles, the Earth's gravitational field and units, its variation, Newton's Law – Geoid, spheroid and normal gravity field, figure of earth. Order of anomalies produced by geological discontinuities, absolute and relative measurement of gravity, gravimeters and their operation in the field. Field procedure, reduction and correction of gravity field data, separation of regional and residuals, upward and downward continuation, interpretation of gravity data obtained over spherical and cylindrical objects, sheet, dike and faults – Applications of gravity methods.	15	CO2

III	Electrical methods – Electrical properties of earth materials – Conduction in rocks, conduction in water-bearing rocks, description of geoelectric sections, classification of electrical methods. Resistivity method – Ohm's Law, resistivity, factors affecting resistivity, effect of homogenous earth, various configurations for resistivity methods, configuration factor, response over a layered earth. AC and DC type resistivity meters, field procedure for electrical profiling and sounding, logarithmic curve matching, advantages of plotting the data on a logarithmic graph paper. Interpretation of profiling and sounding field data, use of modelling in electrical methods, introduction to self-potential, induced polarization methods.	15	CO2
IV	Seismic methods – Fundamentals of elasticity – Young's modulus, Bulk modulus, Poisson's ratio, elastic waves, laws of reflection and refraction, Huygen's principle, Fermat's principle, Principle of superposition, Seismic wave theory – Helmhotz's theorem and seismic wave propagation – Body and surface waves – Primary, Secondary, Rayleigh and Love waves – Seismic energy sources – Detectors – Seismic noises and noise profile analysis – Reduction to a datum and weathering corrections - Short period, long period, broad band and strong motion – Seismic instruments – Seismic channel – Details of geophones – Filters, Amplifier and reproducible and non-reproducible recording – Seismic timer field layout – Arc shooting – Fan shooting – Profile shooting	15	CO2
V	Magnetic prospecting – definition, principles of magnetic prospecting, Palaeomagnetism- Magnetometers – Field procedure for ground magnetic surveys. Data processing – Corrections applied to seismic field data, Simple interpretation of field data – Seismic refraction and reflection data processing – Applications.	15	CO2
	Text Books		
1.	Keller, G.V. and Frischknecht, F.C. (1982) Electrical Methods inGeophysical Prospecting. Pergamon Press, New York.		
2.	Rama Rao, B.S. and Murthy, I.V.R. (1978) Gravity and Magnetic Methods of Prospecting. Arnold Heinemann Publishers, New Delhi		
3.	*Davies, Geoffrey F. (2001). Dynamic Earth: Plates, Plumes and Mantle Convection.* Cambridge University Press. ISBN 0-521-59067-1.		
4.	*Bozorgnia, Yousef; Bertero, Vitelmo V. (2004). Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering.* CRC Press.		
5.	*Pedlosky, Joseph (1987).* Geophysical Fluid Dynamics *(Second ed.).* Springer-		

	Verlag. ISBN 0-387-96387-1.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Dobrin, M.B. (1984) An Introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.
2.	Telford, W.M., Geldart, L.P., Sheriff, R.E. and Keys, D.A. (1976) Applied Geophysics. Oxford-IBH Publishing Co. Pvt. Ltd., New Delhi
3.	*Hardy, Shaun J.; Goodman, Roy E. (2005).* "Web resources in the history of geophysics". American Geophysical Union. *Archived from* the original *on 27 April 2013*. Retrieved 30 September 2011.
4.	*Kivelson, Margaret G.; Russell, Christopher T. (1995). Introduction to Space Physics.* Cambridge University Press. ISBN 978-0-521-45714-9.
5.	*Lowrie, William (2004). Fundamentals of Geophysics.* Cambridge University Press. ISBN 0-521-46164-2
Web Resources	
1.	https://iugg.org/associations-commissions/commissions/sedi/
2.	https://iugg.org/
3.	https://www.usgs.gov/programs/geomagnetism
4.	https://www.udemy.com/course/learn-seismic-data-processing/
5.	https://seg.org/Default.aspx?TabId=176&language=en-US

Course Outcome:

CO1: Student can learn in detail about the Gravity and gravity anomalies, gravity survey, gravity map preparation

CO2: Magnetic fields, magnetic behavior of rocks, magnetic methods – anomalies, preparation of magtnetic anomaly maps

CO3: Thermal and electrical properties of rocks, resistivity method

CO4: Application of electrical method in groundwater exploration

CO5 Seismic method, wave propagation principles, seismic data interpretation.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	2	3	3	3	2	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	2	2	3	2
CO 4	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	2	3	3	2	3	3	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Hydrogeology	Core	Y	-	-	-	5	5	25	75	100

Course Objectives	
	To define different terms and parameters involved in Hydrogeology
	To enumerate the concept and to interpret the processes involved in groundwater
	To describe the importance of groundwater and summarise the occurrence of groundwater
	To interpret the conditions of water resources and to select some areas where the groundwater is being exploited against the natural laws
	To crtitically assess different factors/aspects involve

UNIT	Details	No. of Hours	Course Objectives
I	**Introduction to Hydrogeology:** Water on Earth - Types of water - Distribution of water - Hydrological cycle and its components: precipitation, evaporation, evapotranspiration, infiltration, surface runoff and sub-surface distribution and movement of ground water and their estimation for the purpose of assessing water availability. Water-bearing properties of rock formations: aquifer- isotropic and anistropic, porosity, permeability, compressibility of rocks.	15	CO1
II	**Occurrence and movement of Groundwater:** Vertical distribution of groundwater: zone of aeration and zone of saturation – Geological formations as aquifers – Springs - Darcy's experiment and its limitations, fluid pressure, hydraulic conductivity, transmissitivity – Reynolds Number - Barometric and tidal efficiency of aquifers – Ground water flow- Groundwater flow direction –Unsaturated flow –Steady and unsteady state flow.	15	CO2
III	**Water wells:** Types of wells - Well hydraulics – Cone of depression, radius of influence, drawdown and specific capacity - Drilling of shallow wells and deep wells – Well Completion – Well development – Testing wells for yield- Protection and rehabilitation of well- Collector wells and Infiltration galleries - Tracer tests and slug tests - Ground water budgeting – Ground water levels and water level maps – Safe yield and Conjunctive uses – Artificial recharge and methods.	15	CO2
IV	**Groundwater Quality and Pollution:** Chemical constituents in groundwater: sources and effects - Quality criteria for	15	CO2

	different uses -Geochemical cycle of surface water and ground water- Graphical presentation of groundwater quality data- Dissolved gases in groundwater- Impact of solar energy on groundwater – Sources and causes for pollution of groundwater – Pollution attenuation – Treatment for contaminated groundwater.		
V	**Exploration techniques and Saline water intrusion:** Methods for exploration of ground water – Geological methods, Remote Sensing techniques, geomorphological inputs, gravity, magnetic, seismic and electrical methods – Basics of ground water modeling – Physical, analog and mathematical models, finite difference modeling – Hydrogeology of arid zones of India – Hydrogeology of wetlands. Hydrodynamic equilibrium of fresh and saline water – Ghyben-Herzberg relation- Control of saline water intrusion.	15	CO2
	Text Books		
1.	Freeze, R.A. and Cherry, J.A. (1979) *Groundwater*. Prentice-Hall. London.		
2.	Fetter, C. W. (2018). *Applied Hydrogeology*.Waveland Press. ISBN: 9781478637448. 4th Edition. E-Book.		
3.	De Marsily, G., 1986. Quantitative Hydrogeology: Groundwater Hydrology for Engineers, Academic Press, Inc., Orlando Florida. — Classic book intended for engineers with mathematical background but it can be read by hydrologists and geologists as well. ISBN 0-12-208916-2		
4.	*LaMoreaux, Philip E.; Tanner, Judy T, eds. (2001),* Springs and bottled water of the world: Ancient history, source, occurrence, quality and use, *Berlin, Heidelberg, New York: Springer-Verlag,* ISBN 3-540-61841-4 Good, accessible overview of hydrogeological processes.		
5.	Porges, Robert E. & Hammer, Matthew J., 2001. The Compendium of Hydrogeology, National Ground Water Association, ISBN 1-56034-100-9. Written by practicing hydrogeologists, this inclusive handbook provides a concise, easy-to-use reference for hydrologic terms, equations, pertinent physical parameters, and acronyms		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Todd, D.K. and Mays, L.W. (2013)*Groundwater Hydrology*.John Wiley & Sons, New York. ISBN: 978-81-265-3003-8. 3rd Edition.		
2.	Davis and DeWeist. (1966).*Geohydrology*. John Wiley & Sons, New York.		
3.	Domenico, P.A. & Schwartz, W., 1998. Physical and Chemical Hydrogeology Second Edition, Wiley. — Good book for consultants, it has many real-world examples and covers additional topics (e.g. heat flow, multi-phase and unsaturated flow). ISBN 0-471-59762-7		
4.	Driscoll, Fletcher, 1986. Groundwater and Wells, US Filter / Johnson Screens. — Practical book illustrating the actual process of drilling, developing and utilizing water wells, but it is a trade book, so some of the material is slanted towards the products made by Johnson Well Screens. ISBN 0-9616456-0-1		
5.	Anderson, Mary P. & Woessner, William W., 1992 Applied Groundwater Modeling, Academic Press. — An introduction to groundwater modeling, a little bit old, but the methods are still very applicable. ISBN 0-12-059485-4		

Web Resources	
1.	https://iah.org/
2.	http://www.groundwateruk.org/
3.	https://gw-project.org/books/groundwater-resource-development.
4.	https://www.epa.gov/dwreginfo/drinking-water-regulations.
5.	https://www.guidelinegeo.com/groundwater-prospection

Course Outcome:

CO1: This study helps to understand the Hydrological cycle, Aquifer; flow rates and flow directions , Groundwater fluctuation: types, controlling factors
CO2: Occurrence and movement of Groundwater
CO3: Groundwater wells, types and methods
CO4: Groundwater chemistry: Components of groundwater Groundwater pollution: Arsenic, fluoride and Nitrate
CO5 Salinity in Groundwater , Seawater intrusion and Ghyben-Herzberg Relation

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	2	1	2	3	3	3	2
CO 2	3	3	3	2	1	2	2	3	3	2
CO 3	3	3	3	2	2	3	2	3	3	3
CO 4	3	3	3	3	2	3	2	3	3	3
CO 5	3	3	3	3	2	3	2	3	3	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

PRACTICAL: ECONOMIC GEOLOGY, GEOPHYSICS AND HYDROGEOLOGY

Course Objectives:

- *To identify the economic minerals in hand specimen.*
- *To getting knowledge on reserve estimation.*
- *To interpret and explore data collected from Geophysics and Geochemical methods.*

Course Outcomes* (COs):

CO1:	Remember to Identify the ore and economic minerals in hand specimen
CO2:	Understand the Computation of ore reserves from sampling data
CO3:	Apply Estimation of ore reserves by traditional methods.
CO4:	Analyze the geochemical properties of water
CO5:	Evaluate the data collected from the various geophysical methods
CO6:	Create report based on geophysical survey and geochemical data analysis.

ECONOMIC GEOLOGY AND MINERAL ECONOMICS

Identification and description of the following economic minerals:

Magnetite, Ilmenite, Hematite, Pyrite, Pyrolusite, Psilomelane, Chromite, Wulframite, Chalcopyrite, Malachite, Galena, Magnesite, Bauxite, Stibnite, Cinnabar, Gypsum, Barite, Monazite, Rutile, Sillimanite, Kyanite, Corundum, Calcite, Dolomite, Beryl, Asbestos, Orpiment. Computation of ore reserves from sampling data; Estimation of ore reserves by traditional methods.

GEOPHYSICS

Geological interpretation of magnetic survey data, Study of seismic map of India, Study of seismic profiles of across southern India, Geological interpretation of seismic survey data, Electrical resistivity survey: Wenner and Schlumberger methods, Plotting and interpretation of electrical resistivity survey data.

HYDROGEOLOGY

- Preparation of water table contours.
- Determination of flow direction of water.
- Determination of porosity of rocks.
- Determination of permeability of rocks.
- Analysis and interpretation of hydrographs.
- Estimation of infiltration capacity.
- Chemical analysis of water.
- Pumping test – time drawdown and time recovery tests and evaluation of aquifer Parameters, Step drawdown tests.
- Resistivity survey for groundwater exploration.
- Graphical presentation of water analyses.

Mapping of COs to POs and PSOs

	Course Outcome	**PO Addressed**	**Correlation Level**	**PSO Addressed**	**Correlation Level**	**Cognitive Level**
		PO1 to PO8	L/M/H	PSO1 to PSO8	L/ M/ H	K_1 to K_6
CO1	Remember to Identify the ore and economic minerals in hand specimen	PO1	H	PSO2, PSO3	H	K1
CO2	Understand the Computation of ore reserves from sampling data	PO1,PO3	H	PSO3,	H	K2
CO3	Apply Estimation of ore reserves by traditional methods.	PO5, PO6,	M	PSO4, PSO5	M	K3

CO4	Analysis and interpretation of hydrographs, Determination of porosity and permeability of rocks, chemical analysis of water, pumping test	PO3, PO6	M	PSO3, PSO6	M	K4
CO5	Evaluate the data collected from the various geophysical methods	PO7, PO8	H	PSO7	H	K5
CO6	Create report based on geophysical survey and geochemical data analysis.	PO3, PO8	H	PSO8	H	K6

(L – Low, M – Medium, H – High; K_1 – Remember, K_2 – Understand, K_3 – Apply, K_4 – Analyze, K_5–Evaluate, K_6 – Create)

Semester-III

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Disaster Management	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
	Understand the basics of natural hazards, distinguish hazards and disasters, global trends, vulnerable communities, importance of inter-disciplinary studies.
	Students will comprehend the core part of disaster management i.e. geotechnical aspect, community aspect and environmental aspect and its inter-linkages
	Comprehend the complexity of climate change induced disasters, mapping and monitoring techniques including risk zonation and appropriate technology tools for mitigation.
	Acquiring knowledge on community-based disaster management, disaster risk reduction (DRR), community resilience and the importance of hazard mapping.
	Evaluate the importance of this inter-disciplinary course through case study experiences and to use these skills in the real-world scenario

UNIT	Details	No. of Hours	Course Objective
I	General introduction to natural hazards and disasters: Physical and geodynamic characteristics of earthquakes, tsunamis and storm surges, tropical cyclones, monsoonal floods, landslides. Droughts - different types – monitoring and management and wildfires – Worldwide trends in natural catastrophes and occurrence.	12	CO1
II	Global Climate Change: Global warming and environmental change – Threat of sea level changes on global coasts - Impact on natural resources, environment – Social impact of disasters – Gender, food security, poverty and Climate Change Adaptation.	12	CO2
III	Assessment: Hazard-prone areas identification – Application of remote sensing and GIS tools – Hazard mapping – Risk modeling – Risk zonation and case studies.	12	CO2
IV	Preparedness: Risk reduction concepts – pre-and post-disaster comparison and analysis – Understanding the disaster cycle – Stakeholders' participation and	12	CO2

	preparation of comprehensive management plans – Community-based disaster risk management – Participatory risk assessment – Coastal regulations – Coastal management in tsunami reconstruction – National and international scenarios.		
V	Mitigation and recovery: Inter-relationship between mitigation and recovery – Process for developing hazards mitigation plan, implementation of comprehensive mitigation strategies – Disaster recovery planning – Disaster emergency preparedness and on recovery and reconstruction – Disaster Risk Reduction (DRR) approaches - Early warning systems.	12	CO2
	Text Books		
1.	Handbook of Disaster Research Eds. H. Rodriguez et al., (2006).		
2.	Rajib Shaw and Krishnamurthy, R.R. (2008) Disaster Management – The Global Challenges and Local Solutions, Universities Press, Hyderabad, pp. 560.		
3.	Groundwater Assessment Development and Management, Karanth.K.R. (1987) Tata McGraw Hill Publishing Company, Ltd.		
4.	Miller T.G. Environmental Science. Wadsworth Publishing.US(2004).		
5.	Coates,D.R. Environmental Geology. McGraw Hill.NewYork(1984)		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Shaw, R. and Rouhban, B. (2005) Disaster Reduction and Human Security. UNESCO & Kyoto University.		
2.	Babar, Md. (Ed.) (2007) Environmental Changes and Natural Disasters. New Delhi Publishing Agency.		
3.	Coppola D.P, Introduction to International Disaster Management, Butterworth Heinemann(2007)		
4.	Pine,J.C, Natural Hazards Analysis: Reducing the Impact of Disasters, CRC Press, Taylor and Francis Group(2009)		
5.	Smith K, Environmental Hazards: Assessing Risk and Reducing Disaster Rout ledge Press(2001)		
Web Resources			
1.	https://www.britannica.com/science/geology/sedimentary-petrology		
2.	https://limk.springer.com/chapter/10		
3.	https://www.geo.mtu.edu/UPSeis/hazards.html		
4.	https://www.omafra.gov.on.ca/english/engineer/facts/		
5.	https://geology.com/rocks/rock-salt.shtml		

Course Outcome:

CO1: Understand the need and significance of studying disaster management

CO2: Understand the different types of disasters and causes for disasters.

CO3: Gain knowledge on the impacts Disasters on environment and society

CO4: Study and assess vulnerability of a geographical area.

CO5: Students will be equipped with various methods of risk reduction measures and risk mitigation

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	2	3	3	3	2	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	2	2	3	2
CO 4	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	2	3	3	2	3	3	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	MEDICAL GEOLOGY	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	Understand about relationship of human Health and Geological Processes
CO2	Importance of the Water quality standards and its effects on human health
CO3	Impact of nutrients in water on the nutritional health of humans.
CO4	Analyze the interaction of abundance of iodin and nitrogen in human health
CO5	Impact of Micronutrient Deficiencies in Agricultural Soils and Crops on the Nutritional Health of Humans.

Unit	Details	No. of Hours	Course Objectives
I	Medical Geology- Perspectives and Prospects, Public Health and Geological Processes: An Overview of a Fundamental Relationship. Environmental Biology- Natural Distribution and Abundance of Elements, Anthropogenic Sources, Uptake of Elements on Chemical and Biological Perspective and its functions, Geological Impacts on Nutrition.	12	CO1
II	Pathways and Exposure- Volcanic Emissions and Health, Radon in Air and Water, Arsenic in Groundwater and the Environment. WHO and BIS Standards for drinking water. Fluoride in Natural Waters, soils, sediments, plants. Fluorides and health: Bioavailability of fluoride, Dental fluorosis, Skeletal fluorosis, Dental fluorosis in India, source, nature, cause and extent.	12	CO2
III	Water Hardness and Health Effects, Geochemical basis for tropical endomyocardial fibrosis (EMF), Effect of water hardness on urinary stone formation (urolithiasis), Types of stones: Calcium oxalate, Calcium phosphate, Uric acid, Magnesium ammonium phosphate stones, Cysteine.	12	CO3
IV	Iodine and health: The iodine cycle in the environment, Iodine in drinking water, Iodine in food, Iodine Deficiency Disorders (IDD), Endemic cretinism, Goitrogens. The nitrogen cycle, Nitrate as fertilizers and environment, Nitrogen loading in rice fields, Nitrates from human and animal wastes, Nitrates and health,	12	CO4

	Nitrates and Methemoglobinemia, Nitrates and cancer. Bioavailability of Elements in Soil.		
V	Selenium Deficiency and Toxicity in the Environment, Soils and Iodine Deficiency, Natural Aerosolic Mineral Dusts and Human Health, Animals and Medical Geology. The Impact of Micronutrient Deficiencies in Agricultural Soils and Crops on the Nutritional Health of Humans.	12	CO5
	Total	**60**	

- The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular Unit. There will be equal number of Course objectives and Course outcomes.
- The blooms taxonomy verbs will be given as a separate annexure for your reference.
- Each course outcome should be mapped with the POs.
- The mapping of each CO can be done with any number of POs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Recognize relationship of human Health and Geological Processes	PO, PO6
CO2	Understand of the Water quality standards and its effects on human health	PO1, PO2, PO3
CO3	Identify impact of nutrients in water on the nutritional health of humans.	PO4, PO6
CO4	Diagnose the interaction of abundance of iodin and nitrogen in human health	PO4, PO5, PO6
CO5	Distinguish the impact of Micronutrient Deficiencies in Agricultural Soils and Crops on the Nutritional Health of Humans.	PO3, PO8

Text Books
(Latest Editions)

1.	C.B. Dissanayake and R.Chandrajith (2009). Introduction to Medical Geology, Springer, London H.Catherine, W.Skinner,
2.	Antony R. Berger (2003). Geology and Health: Closing gap, Oxford Univ. press, New York. Iosif F.Volfson (2010). Medical Geology: Current Status and Perspectives, 2010., Russian Geological Society (ROSGEO) Publisher. Moscow.
3.	K.S. Valdiya (2004). Geology, environment, Society, University press(India), Hyderabad. 4. Lawrence K. Wang, Jiaping Paul Chen, Yung-Tse Hung, Nazih K. Shammas (2009). Heavy Metals in the Environment, CRS Press, Taylor & Francis Group, Boca Raton,

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	FL M.M. Komatica, (2004) Medical Geology, Vol.2, Effects of geological environment on Human health, Elsevier, U.K. Oile Selinus, B. Elsevier(2003).
2.	C.B. Dissanayake and R.Chandrajith (2009). Introduction to Medical Geology, Springer, London H.Catherine, W.Skinner,

Web Resources

1.	https://link.springer.com/book/10.1007/978-3-642-00485-8

2.	https://shop.elsevier.com/books/medical-geology/komatina/978-0-444-51615-2

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.

The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	2	3	3	3	3	3	2	2
CO2	3	3	3	3	3	2	2	3
CO3	3	2	3	2	3	3	2	3
CO4	3	3	3	3	2	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

SEMESTER-III

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	RESEARCH METHODOLOGY	SEC	Y	-	-	-	2	4	25	75	100

Course Objectives	
CO1	Understand the formulation of research problem and acquire knowledge in writing research proposal
CO2	Be familiar with data collection
CO3	Apply the concepts of literature survey process
CO4	Analyze the geological sampling and techniques
CO5	Evaluate the sample analysis in various instrumentation

Unit	Details	No. of Hours	Course Objectives
I	Concept and definition of Research: academic, basic, fundamental research, applied research, theoretical, conventional, and experimental research. Concepts and needs of research hypothesis. Research proposal and concepts- developing research proposal in the field of geosciences - research approach and identifying gap areas from literature review - problem formulation and statement of research objective.	12	CO1
II	Types of data: primary and secondary data. Introduction on the techniques of data representation, documentation and representation tools, basic presentation structures, writing a scientific paper, abstract and summary writing and organizing thesis, project reports. Structure of thesis - Copyright waiver- Declaration - Title page - Abstract - Acknowledgments - Table of contents - Introduction - Literature review - Materials and Methods - Results and discussion - Conclusions and suggestions for further work – Summary - References – Bibliography - Footnotes and endnotes and appendices.	12	CO2
III	Literature survey and review- use of digital library - online resource - necessity of review of literatures. Developing of bibliography. Concepts on plagiarism, ISSN and ISBN numbers, impact factors and citation index of research articles and assessing the quality of research articles.	12	CO3
IV	Construction and use of wind rose, fence diagram, Wolf's net, equal area, trilinear diagram. Pre-field preparations, Field sampling equipment's, Preparation of topographic maps, Field mapping and documentation, sampling Procedure and sampling techniques for palaeontological, stratigraphic, petrological,	12	CO4

	geochemical, geophysical and hydrogeological studies. Sample labelling.		
V	Geological Laboratory Procedures: Maceration techniques, thin section making, induration techniques for unconsolidated sediments, tracers and staining techniques. Applications of Polarizing microscopes, ore microscopes, Scanning Electron Microscope, mirror stereoscope, heavy mineral separators (mechanical and electromagnetic). Analytical instruments: General principles, description and uses of following; XRF, XRD, AAS, EPMA, ICP – MS.	12	CO5
	Total	**60**	

- The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular Unit. There will be equal number of Course objectives and Course outcomes.
- The blooms taxonomy verbs will be given as a separate annexure for your reference.
- Each course outcome should be mapped with the POs.
- The mapping of each CO can be done with any number of POs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Identify research problems	PO1, PO2, PO3
CO2	Collect and prepare suitable data for research design	PO1, PO4
CO3	Prepare literature survey and question	PO1, PO2
CO4	Experiments for collection of different geological sampling	PO4, PO5, PO67
CO5	Apply their analytical knowledge through various instruments	PO2,PO3, PO8

Text Books
(Latest Editions)

1.	Bruce, L. B. (2001) Qualitative Research Methods for Social Sciences by, Allyn and Bacon, Boston.
2.	John, W. C., (2011) Research Design: Qualitative, Quantitative and Mixed Methods Approaches, Sage Publications, Thousand Oaks.
3.	Lester, James, D. and Lester Jr. J. D., (2007) Principles of Writing Research Papers , Longman, New York.
4.	Frank A. Settle, (1997) Handbook of Instrumental Techniques for Analytical Chemistry by, Prentice Hall, Upper Saddle River, NJ.
5.	Hutchinson, C.S., (1974) Laboratory hand book of Petrographic Techniques, John Wiley

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	Phillips, E.M and Pugh, D.S., (1994) 'How to get a PhD: a handbook for students and their supervisors'. Open University Press, Buckingham, England.
2.	Tufte, E.R.,(1983) The visual display of quantitative information'. Graphics Press, Cheshire, Conn.
3.	Mishra R.P., (1989) Research Methodology. Concept Publishing Co, New Delhi.
4.	Comption R.R., (1962) Manual of field geology, Wiley.

5.	Lahee H., (1959) Field geology, McGraw-Hill.
6.	D.L. Elhance (1973) Practical Problem in Statistics. KitabMahal, Allahabad,
7.	Kothari. C. R. (2004) Research Methodology: Methods and Techniques, New Age International.
8.	Kumar, Rajendar (2009) Research Methodology, Pub. APH Publishing .
9.	D K (2006) Research Methodology, Pub. Excel Books India.
10.	Gupta, Mukul and Gupta, (2010) Deep Research Methodology, Pub.PHILearning Pvt. Ltd.
Web Resources	
1.	https://in.sagepub.com/en-in/sas/book/research-methodology-4
2.	https://mfs.mkcl.org/images/ebook/Fundamental%20of%20Research%20Methodology%20and%20Statistics%20by%20Yogesh%20Kumar%20Singh.pdf

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.

The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3	3	2	3	3	3	2	2
CO2	2	2	3	3	3	2	3	2
CO3	2	3	3	3	2	3	2	1
CO4	2	2	2	3	3	2	2	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

SEMESTER-III: INTERNSHIP

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	INTERNSHIP/INDUSTRIAL TRAINING	Core	N	-	-	-	2		50	50	100
	Course Objectives										
UNIT	**Details**							**No. of Hours**		**Course Objectives**	
	Students should be taken to the various geological field visit according to academic year syllabus in each year.										
1.											
2.											
References Books (Latest editions, and the style as given below must be strictly adhered to)											
1.	Guide to Scientific and Technical Writing - P. G. Cooray 1992. ISBN - 9559543407, 9789559543404, 159 pages										
Web Resources											
1.	https://www.springer.com/journal/12594										

Semester-IV

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Engineering and Mining Geology	Core	Y	-	-	-	5	6	25	75	100
Course Objectives											
CO1	To enumerate the different aspects of engineering geology										
CO2	To briefly summarise the properties and significance of different Earth materials on the basis of engineering geology										
CO3	To briefly summarise the properties and significance of different Earth materials on the basis of engineering geology										
CO4	To employ the students in geotechnical investigations and make them understand the various mining methods adopted in addition to estimation of ore reserves										
CO5	To theories the knowledge										

UNIT	Details	No. of Hours	Course Objectives
I	Engineering geology: Engineering properties of rocks, soft sediments and soils – Geological investigations pertaining to bridges, buildings, dams, highways and airfields – Types of reservoirs – Geological investigations of reservoir sites.	18	CO1
II	Problems pertain to tunneling in hard and soft grounds – Geological investigations preceding tunneling – Geological investigations pertaining to harbors, docks, coastal erosion – Shoreline engineering – Construction of retaining walls – Problems and solutions.	18	CO2
III	Mining geology: Terminology used in metal mines – Terminology used in coal mines – Prospecting and exploration – Alluvial mining methods – Quarrying – Opencast mining – Mine supports – Mine atmosphere.	18	CO2
IV	Methods of underground metal mining: Without artificial supports – With artificial supports – Cut and fill methods – Shrinkage stoping – Caving methods.	18	CO2
V	Coal mining: Longwall advancing – Longwall retreating – Board and Pillar method – Horizon mining.	18	CO2
	Text Books		
1.	Arogyaswamy, R.N.P. (1996) *Courses in Mining Geology*. 4th Edition. Oxford and & IBH Publishing Co., New Delhi.		

2.	Peters, W.C. (1978) *Exploration and Mining Geology*. 2nd Edition. John Wiley & Sons, New York
3.	Vitousek P.M, Global Change and Natural Resource Management, Beyond global warming:Ecology and global change. Ecology 75, 1861-1876.
4.	Miller T.G. Jr, Environmental Science, Wadsworth Publishing Co. (TB)
5.	Thomas,R.T, Introduction to Mining methods, McGraw Hill, New York(1986)

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Blyth, F.G.H. (1963) *A Geology for Engineers*. 4th Edition. The ELBS & Edward Arnold (Publishers) Ltd., London
2.	Legget, H.F. and Hatheway, A.W. (1988) *Geology and Engineering*. 3rd Edition. McGraw-Hill Book Co., New York
3.	Arogya swamy R.N.P, Courses in Mining Geology, Oxford &IBH, New Delhi(1988)
4.	Singh, R.D, Coal Mining, New Age Publishers, Delhi(1998)
5.	Hartman, H.L, SME Mining Engineering Handbook, SME Colorado, USA (1992)
Web Resources	
1.	https://link.springer.com/chapter/10.1007/
2.	https://www.sciencedirect.com/sciencedirect.com/science/article/pii/
3.	https://www.google.com/ur1?sa=t&source=web&rct=j&ur1=https//mines.gov.in/
4.	https://www.ncbi.nml.gov/books/
5.	https://www.sciencedirect.com/sciencedirect.com/science/article/pii/

Course Outcome:

CO1: Students can understand the Engineering properties of rocks

CO2: student can apply the knowledge and ideals on geological investigations for constructions

CO3: Getting knowledge about the alluvial mining methods

CO4: Study the methods of underground metal mining

CO5: Understand the knowledge about the coal mining methods and techniques

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	2	3	3	1	2	3	1	2	1	3
CO 2	2	3	3	1	2	3	1	2	1	3
CO 3	2	3	3	1	2	3	1	2	1	3

CO 4	2	3	3	1	2	3	1	2	1	3
CO 5	2	3	3	1	2	3	1	2	1	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-IV

PSO Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Engineering, Mining Geology Practical	Core	Y	-	-	-	5	6	50	50	100
	Course Objectives										
CO1	To enumerate need of practical knowledge in the field										
CO2	To conduct the field surveys for mineral exploration										
CO3	To briefly summarise the various mining methods adopted in addition to estimation of ore reserves										
CO4	To employ the students in geotechnical investigations										
CO5	To critically assess the properties of rocks, minerals and ores										

UNIT	Details	No. of Hours	Course Objectives
I	Engineering Geology: Poisson ratio, dynamic elastic modules, Young modules, shear modules, Porosity and permeability determination, foundation strength, tensile strength Atterberg limits test, plastic limit test, Dry density test, Calfifornia bearing test, consolidation test and penetration test.	30	CO1
II	Mining Geology: Assaying – Determination of average grade – Determination of average width – Uniform sampling – Variable sampling – Influence of interval.	30	CO2
III	Drilling: Core and sludge recovery – Estimation of ore reserves – Determination of coal pillar size – Determination of ideal shaft location.	30	CO2

1.	Krynine, D.P. and Judd, W.R. (1957) *Principles of Engineering and Geotechniques*. McGraw-Hill Book Co., New York
2.	Legget, H.F. (1962) *Geology and Engineering*. McGraw-Hill Book Co., New York
3.	Dobrin. M.B– introduction to Geophysical prospecting. McGraw–Hill, 1981
4.	Mason. B, Principles of geochemistry– Willey Toppan, 1966.
5.	H.E. Hawkes and Webb, Geochemistry in Mineral Exploration, Harper and Row

	Publishers1965.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Zaruba, Q. and Menci, V. (1976) *Engineering Geology*. Elsevier Scientific Publishing Co., Amsterdam
2.	Arogyaswamy, R.N.P. (1980) *Courses in Mining Geology*. 2nd Edition. Oxford and & IBH Publishing Co., New Delhi.
3.	Govett, G.J.S.Handbook of Exploration Geochemistry.(Ed) , 1983.
4.	Craig,R.C& D.V. Vaughan. Ore Microscopy and Ore Petrography. Wiley. New York.(1985)
5.	Aiyengar, N.K.N, Minerals of Madras, Dept.of Industries &Commerce. Guindy, Madras, (1964).
Web Resources	
1.	1. https://www.Sciencedirect.com
2.	https://www.geos.iitb.ac.in
3.	https://pubs.usgs.gov
4.	https://www.britannica
5.	https://www.intechopen.com

Course Outcome:

CO1: The student is introduced to a detailed discussion, study, and application of engineering properties of rocks

CO2: Student can learn the formulas for Estimation of ore reserves

CO3: student learn the mining geology calculations

CO4: Students can understand the sophisticated instrumental operations for analysis

CO5: Student apply the techniques for analysis of rocks/minerals/ores.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	2	2	3	2	1	3	2	3	2	2
CO 2	2	2	3	2	1	3	2	3	2	2
CO 3	2	2	3	2	1	3	2	3	2	2
CO 4	2	2	3	2	1	3	2	3	2	2
CO 5	2	2	3	2	1	3	2	3	2	2

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-IV

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	GEOCHEMISTRY	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	Remember the fundamental of geochemistry
CO2	Understand the earth elements
CO3	Apply the concepts of petrogenesis
CO4	Analyze the application of isotopes in dating studies
CO5	Evaluate the geochemical prospecting

Unit	Details	No. of Hours	Course Objectives
I	Origin of the solar system. Earth in relation to the solar system. Cosmic abundance of elements. Periodic table and special properties of transition and rare earth elements. Goldschmidt's geochemical classification of elements. Geochemical cycles. Geochemical constitution of earth's crust, mantle, core and meteorite.	12	CO1
II	Nernst's partition coefficient (compatible and incompatible elements), LILE and HFSE. Major, minor and trace elements, REEs and PGEs. Principles of ionic substitution in minerals. Concept of simple distribution coefficient; element partitioning in mineral assemblages and its use in P-T estimation.	12	CO2
III	Application of geochemistry in petrogenesis- Harker variation diagrams, differentiation index, AFM diagram, TAS classification diagram, spider diagrams, REE diagram and tectonic discrimination diagram for granitic and basaltic rocks. Oxidation potential, Eh-pH diagrams and their applications in sedimentation process	12	CO3
IV	Introduction to isotope geochemistry. Stable isotopes and their applications. Various decay mechanisms- alpha, beta (positron and negatron), gamma decay, electron capture and branched decay. Law of radioactivity and principles of isotopic dating. Geochronology and age of the Earth: Using Radioactive decay schemes such as U-Pb, Rb-Sr, and Sm-Nd systems for dating of rocks.	12	CO4

	Radioactive decay, half-life and basic equation for age calculation.		
V	Principles of geochemical prospecting. Geochemical studies of aerosols and surface, marine and ground water. Chemistry of natural waters. Redox reactions and Eh-pH diagrams and their applications. Importance of Trace elements and REEs in fractional crystallization and partial melting during magmatic processes.	12	CO5
	Total	**60**	

The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular Unit. There will be equal number of Course objectives and Course outcomes.
The blooms taxonomy verbs will be given as a separate annexure for your reference.
Each course outcome should be mapped with the POs.
The mapping of each CO can be done with any number of POs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Remember the fundamental of geochemistry	PO1
CO2	Understand the earth elements	PO1, PO2, PO3
CO3	Apply the concepts of petrogenesis	PO4, PO6
CO4	Analyze the application of isotopes in dating studies	PO4, PO5,
CO5	Evaluate the geochemical prospecting	PO3, PO8

Text Books
(Latest Editions)

1.	Faure, G. 1986: Principles of Isotope Geology. John Wiley.
2.	Gill, R. 1997: Chemical Fundamentals of Geology. Chapman & Hall.
3.	Govett, G.J.S. (Ed) 1983: Handbook of Exploration Geochemistry. Elsevier.
4.	Henderson, P. 1987: Inorganic Geochemistry. Pergammon Press.
5.	Hoefs, J.M. 1980: Stable Isotope Geology. John Wiley.

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	Krauskopf, K.B. 1967: Introduction to Geochemistry. McGraw Hill.
2.	Marshal, C.P. and Fairbridge, R.W. 1999: Encyclopaedia of Geochemistry. Kluwer Academic.
3.	Mason, B. and Moore, C.B. 1991: Introduction to Geochemistry. Wiley Eastern.
4.	Nordstrorm, D.K. and Munoz, J.L. 1986: Geochemical Thermodynamics. Blackwell.
5.	Rastogi, R.P. and Mishra, R.R. 1993: An Introduction to Chemical Thermodynamics. Vikas Publishing House.
6.	Krauskopf, K.B. 1967: Introduction to Geochemistry. McGraw Hill.

Web Resources

1.	www.irsm.cas.cz/materialy/oddeleni/2/Geochemistry-book.pdf

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.

The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3	3	2	3	3	3	2	2
CO2	3	3	2	3	3	2	3	3
CO3	3	3	3	2	3	3	1	1
CO4	3	2	2	3	3	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

Semester-IV

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Petroleum Exploration and Mud logging	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
	To Identify and enumerate the methods of drilling. To describe and explain the oil resources. To summarize the whole procedure involved in exploitation of oil resources
	To interpret and select the prospering area for exploitation of
	Compare and contrast the differences between prosperous and non-economical sites.
	Critically assess and review the ideas at strategic situation at the drilling site
	Can make hypothesis to achieve the target

UNIT	Details	No. of Hours	Course Objectives
I	Petroleum Exploration – Petroleum Geology - Applied Mathematics in Petroleum Engineering. Oil Field Drilling – Onshore and Offshore Drilling - Drilling Rigs – Well Types - The Drill String – Drill Bits – Well Profile- Bore-hole volume Calculation and Displacement – Lag time – Basic Hydraulics - Drilling Fluids - Formation Pressure –Bore Hole Problems - Coring – Objective of Coring and Core Analysis- Casing and Cementing – Fishing - Well Completion – Well Testing.	12	CO1
II	Basics of Mudlogging –Surface Logging - Tasks and Responsibilities - Geological Surveillance – Cutting Sampling - Collection, Examination – Lithological and Mineralogical Description–Calcimetry - Oil Shows- Fluorescence and Cut Fluorescence – Thin Sections – Chemical Tests – Gas Sampling – Hydrocarbon Gas Analysis – Pore Pressure calculation - Cutting Evaluation – Sample Examination Procedure - Wellsite Geo-Chemistry - Gases other than Hydrocarbons, Communication Skill - QHSE – Worksite Environmental Hazards – Offshore Safety - Quality Control.	12	CO2
III	MudloggingServices, Mudlogging Sensors –Operations – Maintenance - Inspection and calibrations–Trouble	12	CO3

	shooting - Technical Specification - Reporting - Final Well Reports - Mudlogging Unit Installation and Maintenance.Practical Mudlogging, Lab Training on Rig up and Rig Down of Sensors, Equipment and Monitoring Realtime drilling followed by a Rig site Visit.		
IV	Down-hole Measurement - Measuring While Drilling (MWD) – MWD Principle – Telemetry Types – Formation Evaluation MWD- Sensor information – Natural Gama ray – Formation resistivity – Focused Current Resistivity (FCR) – Toroidal Resistivity – Electromagnetic Wave Propagation Resistivity – Multiple Propagation Resistivity (MPR) – Geo-Steering-Neutron Porosity MWD Tools – Formation Density MWD Tools – Drilling Performance MWD.	12	CO4
V	Down-hole Logging - Logging While Drilling (LWD) – Temperature Logs – Caliper Logs – Self Potential Logs (SP) – Resistivity & Conductivity Logs – Gama ray and Spectral Gama ray logs – Sonic Logs – Density and Photo Electric factor Logs – The Neutron Log – The dip meter – Imaging Logs –MDT Sampling - Lithology reconstruction from Logs- Facies Sequences and depositional environments from Logs – Sequence Stratigraphy and Stratigraphy.	12	CO5
1.	Levorsen, A.J. (2004). *Geology of Petroleum*, CBS Publishers and Distributors Pvt Ltd., Chennai. 2nd Edition.		
2.	Bhagwan Sahay. (1997). *Petroleum Exploration and Exploitation Practices*, Allied Publishers Limited, Chennai. 2nd Edition.		
3.	Geology& Mineral Resources of the States of India. Misc Pub.No.30.Geological Survey of India. Kolkota. (Several individual volumes available online at GSI portal) GSI(2005).		
4.	The Mudlogging Handbook – Alun Whittaker		
5.	Brian Frehner. Finding Oil: The Nature of Petroleum Geology, 1859–1920 (University of Nebraska Press; 2011) 232 p		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Mudlogging Training Manuals – GEOLOG International B.V		
2.	The Mudlogging Handbook – Alun Whittaker		
3.	An Introduction in Stratigraphy, Stamp L.D, (1964), Thomas Murby, Museum St, WCI, London.		
4.	Stratigraphic Principles and Practices, Weller, J.M, (1962), Harper & Bros, New York		

5.	Wadia,D.N, Geology of India, McMillan India Delhi(1953)
Web Resources	
1.	https://stratigraphy.org/
2.	https://www.sepm.org/
3.	https://www.geosocindia.org/
4.	https://www.moes.gov.in/
5.	https://isegindia.org/

Course Outcome:

CO1: Students gain knowledge about the Petroleum Exploration

CO2 Students learn about the Basics of Mudlogging

CO3: Students get knowledge on MudloggingServices, Mudlogging Sensors –Operations – Maintenance

CO4: Students know about the Down-hole Measurement

CO5: Students able to learn on Down-hole Logging

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	2	3	3	3	3	3	3	3	2	3
CO 2	2	3	3	3	3	3	3	3	2	3
CO 3	2	3	3	3	3	3	3	3	2	3
CO 4	2	3	3	3	3	3	3	3	2	3
CO 5	2	3	3	3	3	3	3	3	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-IV

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Field Mapping	SEC	Y	-	-	-	2	4	50	50	100
Course Objectives											
	Students have to visit to the various structural and rock formation										
	Prepare the report										

UNIT	Details	No. of Hours	Course Objectives
I	Use of clinometer compass for geographic directions, taking bearing and back bearing, strike and dip, reading of and locating oneself on toposheet – Use of GPS for co-ordinates and mapping of features – Geomorphological mapping.	12	CO1
II	Visit to igneous rock outcrops for mapping, collection of rock samples and field set-up studies– Mapping of dikes and veins – Thin section studies of rocks .	12	CO2
III	Visit to sedimentary terrain for mapping of strata and collection of fossils.	12	CO2
IV	Visit to metamorphic terrain for mapping of rocks and metamorphic structures, collection of rock samples – Thin section studies.	12	CO2
V	Geophysical investigations – Field measurements using gravity, magnetic and electrical methods.	12	CO2
	Total	60	

1.	Brian Simpson. (1968). *Geological Maps*. Pergamon Press Limited, Oxford.
2.	Lisle, R.J. (1988). *Geological Structures and Maps*. Pergamon Press, Oxford.
3	Gass, J.G., Butcher, N.E., Clark, P., Francis, P.W., Jackson, D.E., McCurry, P., Skipsey, E., Smith, P.J., Stevenson, J., Thorpe, R.S., Turner, C., Wilson, R.C.L., Wright, J.B. (1972). *Field Relations – A Second Level Course in Science*. The Open University Press, London

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Thomas, J.A.G. (1977). *An Introduction to Geological Maps*. George Allen and Unwin (Publishers) Limited, London. 2nd Edition.
2.	Bhattacharya, D.S. and Bagchi, T.C. (1973). *Elements of Geological Map Reading and Interpretation with Exercises*. Orient Longman Limited, Calcutta
Web Resources	
1.	https://pubs.geoscienceworld.org/jgs
2.	https://www.geosocindia.org/index.php/gsi/pages/view/ed
3.	https://www.gsi.gov.in/webcenter/portal/OCBIS

Course outcome:

CO1: Student apply the knowledge on use of clinometer compass for geographic directions

CO2: Students studied practically on the collection of rock samples and field set-up studies

CO3: Students can get the field exposure and field knowledge for identification of rock types

CO4: Students studied the mapping of rocks and metamorphic structures

CO5: Student trained the Geophysical investigations using geophysical instruments

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	3	1	3	2	3	1	1
CO 2	3	3	2	3	1	3	2	3	1	1
CO 3	3	3	2	3	1	3	2	3	1	1
CO 4	3	3	2	3	1	3	2	3	1	1
CO 5	3	3	2	3	1	3	2	3	1	1

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

CORE: PROJECT WITH VIVA VOCE

Credit:5 Hours:10

Marks: Internal:50 and External:50

- Group Project oriented dissertation based on university guidelines must be submitted one week before the Practical exams.
- Project evaluation and Viva-Voce.
- Internal 50 marks
- External 50 marks evaluated by the external examiner.
- Total 100 marks

Semester-IV: Geological Field visit

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Geological Field visit	Core	-	-	-	-	3	-	50	50	100

Course Objectives	
	Understand the occurrence of various mineral resources across the country.
	Students will comprehend the importance of various mining methods that are being adopted in the country.
	Interpret the occurrence of mineral resources and its relationship with various geological and geotechnical processes.
	Acquiring practical knowledge through actual field visits and interaction with subject experts
	Evaluate the importance of mineral exploration techniques.

UNIT	Details	No. of Hours	Course Objectives
I	Students will be taken to various mines and mineral exploration industries across the country to gain first hand field experience on various mining methods, R&D activities in mineral exploration, interaction with subject experts in various industries and organizations involved in mineral exploration activities.		CO1

	Text Books
1.	Lisle, R.J. (1988). Geological Structures and Maps. Pergamon Press, Oxford.
2.	Brian Simpson. (1968). Geological Maps. Pergamon Press Limited, Oxford
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Thomas, J.A.G. (1977). *An Introduction to Geological Maps*. George Allen and Unwin (Publishers) Limited, London. 2nd Edition.
2.	Bhattacharya, D.S. and Bagchi, T.C. (1973). *Elements of Geological Map Reading and Interpretation with Exercises*. Orient Longman Limited, Calcutta.
Web Resources	
1.	Journal of Geological Society

Course outcomes

CO1: students learn the practical knowledge in the field visit

CO2: students identify and collect the rock specimens in the field visit

CO3: students experienced in mining areas and learn about the mining techniques.

CO4: students get interaction with eminent scientist at various institutions during filed visit

CO5: Students prepare the field training reports and gain knowledge about the geological sites.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	2	2	3	2	1	3	2	3	2	2
CO 2	2	2	3	2	1	3	2	3	2	2
CO 3	2	2	3	2	1	3	2	3	2	2
CO 4	2	2	3	2	1	3	2	3	2	2
CO 5	2	2	3	2	1	3	2	3	2	2

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0