



GUJARAT PUBLIC SERVICE COMMISSION

Advertisement No. : 43/2020-21

Syllabus for the Competitive Examination

of

Hydrologist, under the Gujarat Water
Supply and Sewerage Board, Gujarat State

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Scheme of competitive Examination for Hydrologist

Note: The medium of the examination shall be English. The medium of Part I General Studies of Paper-1 shall be in Gujarati and English. Gujarati and English Papers in Main Examination shall be in respective Language only. In case of question of interpretation of syllabus, the interpretation of English shall be final.

I. Preliminary Examination

| Paper No. | Nature of Exam | Name of the paper | Time | Total Allotted Marks |
|-------------|----------------|--------------------------|---------|----------------------|
| 1. | Objective | Part-I General Studies | 2 Hours | 100 |
| | | Part-II Geology Aptitude | | 100 |
| 2. | | Geology | 3 Hours | 300 |
| Total Marks | | | | 500 |

The preliminary test is a screening test only and marks obtained in the preliminary test shall not be counted for preparing final merit.

II. Main Examination

(For only those candidates who are declared qualified in Preliminary Examination)

| Paper No. | Nature of Exam | Name of Paper | Time | Total Allotted Marks |
|---|----------------------------|---------------|---------|----------------------|
| 1. | All Papers are Descriptive | Gujarati | 2 Hours | 100 |
| 2. | | English | 2 Hours | 100 |
| 3. | | Geology I | 3 Hours | 200 |
| 4. | | Geology II | 3 Hours | 200 |
| 5. | | Geology III | 3 Hours | 200 |
| Total Marks of written Examination | | | | 800 |
| Interview (Only for the candidates who are declared qualified in Main Written Examination) | | | | 100 |
| Total Marks to be considered for Final Selection | | | | 900 |

**Syllabus of Preliminary Examination for
Hydrologist**

Subject Code: GEP1

(objective)

Paper-1: General Studies and Geology Aptitude

(Preliminary Examination)

| | | |
|------------------|-----------------------------|---------------------|
| Marks-200 | No. of Questions-200 | Time-2 Hours |
|------------------|-----------------------------|---------------------|

Part-I General Studies

Marks-100

Medium: English/Gujarati

1. Indus valley Civilization: Features, Sites, Society, Cultural History, Art and Religion. Vedic age. Important Dynasties of India and Gujarat – Impact and Contribution, Important Policies, their administration, economy, society, religion, literature, arts and architecture. India’s Freedom Movement, Revolutionaries in India and abroad. Achievements and administrative reforms of the rulers of princely states of Saurashtra, Kutchh and Gujarat.
2. Cultural Heritage of India and Gujarat: Art forms, Literature, Litterateurs, Sculpture and Architecture, Important organizations and institutions.
3. Geography of India and Gujarat: Physical, Social and Economic. General issues, legal aspect, policies and treaties on Environment Ecology, Bio-diversity and Climate Change. Forest and Wildlife Conservation in India. Environmental Hazards, Pollution, Carbon Emission, Global warming.
4. Indian Constitution: Evolution, features, Preamble, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Amendments, Significant Provisions and Basic Structure. Panchayati Raj, Public Policy and Governance. Rights Issues (Human rights, Women rights, SC/ST rights, Child rights) etc. Important Policies and Programmes of Central and State Governments. India’s Foreign Policy: International Relations, Important Institutions, Agencies and Fora, their structure and mandate.
5. Indian Economy: Emergence and development of planning exercise in India, Performance, Dynamics, Challenges, New Initiatives, Reforms etc. by the State and Central Government. Important Events, Developments and Social Sector Initiatives. NITI Aayog: aims, constitution and functions. Social Audit. Regulatory framework for money and banking: concepts, structure and role.

6. Science and Technology: Relevance of Science & Technology to the day to day life; Institutions and Organization in India promoting integration of Science, Technology and Innovation, their activities and contribution; Contribution of Prominent Indian Scientists. Awareness in the field of Information and Communication Technology (ICT), Space Technology, Technology in Defence, Biotechnology, Nanotechnology etc. Energy policy of India, Nuclear Policy of India.
7. Current Events of Regional, National and International importance.

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૧. સિંધુ ખીણની સભ્યતા: લાક્ષણિકતાઓ, સ્થળો, સમાજ, સાંસ્કૃતિક ઈતિહાસ, કળા અને ધર્મ. વેદિક યુગ. ભારત અને ગુજરાતના રાજવંશો-અસરો અને પ્રદાન, મહત્વની નીતિઓ, તેમનું વહીવટી તંત્ર, અર્થતંત્ર, સમાજ, ધર્મ, કલા, સ્થાપત્ય અને સાહિત્ય. ભારતની સ્વતંત્રતા માટેની ચળવળ, ભારત અને વિદેશમાં ભારતીય ક્રાંતિકારીઓ. સૌરાષ્ટ્ર, કચ્છ અને ગુજરાતના દેશી રાજ્યોના શાસકોના સુધારાવાદી પગલાઓ અને સિદ્ધિઓ.
૨. ભારત અને ગુજરાતનો સાંસ્કૃતિક વારસો : કળાસ્વરૂપો, સાહિત્ય, સાહિત્યકારો, શિલ્પ અને સ્થાપત્ય, મહત્વની સંસ્થાઓ અને સંગઠનો.
૩. ભારત અને ગુજરાતની ભૂગોળ : ભૌતિક, સામાજિક અને આર્થિક. પર્યાવરણની જાળવણી, બાયોડાયવર્સિટી (જૈવ વિવિધતા) અને ક્લાઈમેટ ચેન્જ માટેના સામાન્ય મુદ્દાઓ, કાયદાકીય પાસાઓ, નીતિઓ અને સંધિઓ. ભારતમાં વન અને વન્યજીવન સંરક્ષણ. પર્યાવરણીય આપત્તિઓ, પ્રદૂષણ, કાર્બન ઉત્સર્જન અને વૈશ્વિક ગરમી (તાપવૃદ્ધિ).
૪. ભારતીય બંધારણ: ઉદભવ અને વિકાસ, લાક્ષણિકતાઓ, આમુખ, મૂળભૂત અધિકારો અને ફરજો, માર્ગદર્શક સિદ્ધાંતો, બંધારણીય સુધારા, મહત્વની જોગવાઈઓ અને અંતર્નિર્હિત માળખું. પંચાયતી રાજ. જાહેર નીતિ અને શાસન. અધિકાર સંલગ્ન મુદ્દાઓ (માનવ અધિકાર, સ્ત્રીઓના અધિકાર, એસસી-એસટી અધિકારો, બાળકોના અધિકાર) ઈત્યાદી. કેન્દ્ર અને રાજ્ય સરકારની અગત્યની નીતિઓ અને કાર્યક્રમો. ભારતની વિદેશનિતિ: આંતરરાષ્ટ્રીય સંબંધો, મહત્વની સંસ્થાઓ, એજન્સી, વિવિધ સંગઠનો, તેમનું માળખું અને અધિકૃત આદેશ.
૫. ભારતીય અર્થતંત્ર: ભારતમાં આયોજનની કામગીરીનો ઉદભવ અને વિકાસ. કેન્દ્ર અને રાજ્ય સરકારની કામગીરી, ગતિશીલતા, પડકારો, નવી પહેલ, સુધારણા વગેરે. અગત્યની ઘટનાઓ, વિકાસ અને સામાજિક ક્ષેત્રની પહેલ. નીતિ આયોગ: ઉદ્દેશો, બંધારણ અને કાર્યો. સામાજિક ઓડિટ. નાણાં અને બેન્કિંગ માટે નિયમનકારી માળખું: વિભાવનાઓ, માળખું અને ભૂમિકા.
૬. વિજ્ઞાન અને ટેકનોલોજી: વિજ્ઞાન અને ટેકનોલોજીનું સ્વરૂપ અને ક્ષેત્ર, રોજબરોજના જીવનમાં વિજ્ઞાન અને ટેકનોલોજીની પ્રસ્તુતતા, ભારતમાં વિજ્ઞાન, ટેકનોલોજી અને ઇનોવેશન સાથે સંકળાયેલી વિવિધ સંસ્થાઓ, તેમની પ્રવૃત્તિઓ અને યોગદાન, પ્રસિદ્ધ

ભારતીય વૈજ્ઞાનિકોનું યોગદાન. ઈન્ફર્મેશન અને કોમ્યુનિકેશન ટેકનોલોજી (આઇસીટી), અંતરીક્ષ/અવકાશ અને સંરક્ષણ સેવાઓમાં ટેકનોલોજી, બાયોટેકનોલોજી અને નેનોટેકનોલોજી વગેરે ક્ષેત્રોમાં જાગૃતિ, ભારતની ઉર્જા નીતિ અને પરમાણુ નીતિ.

૭. પ્રાદેશિક, રાષ્ટ્રીય અને આંતરરાષ્ટ્રીય કક્ષાની મહત્વની સાંપ્રત ઘટનાઓ

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Part II Geology Aptitude

Marks:100

Medium: English

1. Calculation of Groundwater flow.
2. Calculation of specific capacity
3. Calculation of Discharge on 90° V Notch
4. Calculation of specific Yield
5. Calculation of specific Retention
6. Calculation of Safe yield (Q in m³/Minute)
7. Volumetric calculations
8. Calculation of annular space around the screen pipe of a tube well
9. Calculation of Gravel quantity to be filled in annular space of a tube well
10. Values of porosity, specific yield, specific retention by various formations like soil, sand, gravel, limestone, sandstone, granite, basalt
11. Groundwater development categories like 1.safe, 2. Semi-Critical, 3. Critical, 4. Over-exploited & 5. Saline
12. Age in million years of different Era/System like Pre-Cambrian, Mesozoic, Jurassic etc.
13. Type of Drilling in different formations like hard rocks (basalt, Granite, etc.) and Alluvial areas.
14. Type of drainage patterns- There are six basic drainage patterns:
 - Dendritic (Treelike) - granites.
 - Trellis (Grapevine pattern) - lime stones
 - Radial - dome structure
 - Parallel (Horse tail) - in valley fills
 - Annular - around a dome or plunging fold nose
 - Rectangular - faulted and jointed rocks.
15. Fresh water availability in Gujarat
16. Type of aquifers- Aquiclude, aquifuge, aquitard, confined aquifer/Unconfined aquifer
17. Cement sealing or grouting in a tube well.
18. Artesian well
19. Water Divide
20. General mathematical aptitude
21. Logical Reasoning and Analytical Ability.
22. Data interpretation, Data Analysis, Data sufficiency, Probability.

Paper-2: Geology (Preliminary Examination)

| | | | |
|------------------|-----------------------------|------------------------|---------------------|
| Marks-300 | No. of Questions-300 | Medium- English | Time-3 Hours |
|------------------|-----------------------------|------------------------|---------------------|

1. Physical Geology

Principle of uniformitarianism; origin, differentiation and internal structure of the Earth; origin of atmosphere; earthquakes and volcanoes; continental drift, sea-floor spreading, isostasy, orogeny and plate tectonics; geological action of rivers, wind, glaciers, waves; erosional and depositional landforms; weathering processes and products.

2. Structural Geology

Stress, strain and rheological properties of rocks; planar and linear structures; classification of folds and faults; Mohr's circle and criteria for failure of rocks; ductile and brittle shear in rocks; study of toposheets, V-rules and outcrop patterns; stereographic projections of structural elements.

3. Mineralogy

Elements of symmetry, notations and indices; Bravais lattices; chemical classification of minerals; isomorphism, polymorphism, solid solution and exsolution; silicate structures; physical and optical properties of common rock forming minerals- olivine, garnet, pyroxene, amphibole, mica, feldspar and quartz.

4. Igneous Petrology

Magma types and their evolution; IUGS classification of igneous rocks; forms, structures and textures of igneous rocks; applications of binary and ternary phase diagrams in petrogenesis; magmatic differentiation and assimilation; petrogenesis of granites, basalts, komatiites and alkaline rocks (carbonatite, kimberlite, lamprophyre and nepheline syenite).

5. Metamorphic Petrology

Limits, types and controls of metamorphism; metamorphic structures- slate, schist and gneiss; metamorphic textures- pre, syn and post tectonic porphyroblasts; concept of

metamorphic zone, isograd and facies; geothermal gradients, facies series and plate tectonics.

6. Sedimentology

Origin of sediments; sedimentary textures, grain-size scale; primary sedimentary structures; classification of sandstone and carbonate rocks; siliciclastic depositional environments and sedimentary facies; diagenesis of carbonate sediments.

7. Paleontology

Fossils and processes of fossilization; concept of species and binomial nomenclature; morphology and classification of invertebrates (Trilobites, Brachiopods, Lamellibranchs, Gastropods and Cephalopods); evolution in Equidae and Hominidae; microfossils-Foraminifera, Ostracoda; Gondwana flora.

8. Stratigraphy

Law of superposition; stratigraphic nomenclature- lithostratigraphy, biostratigraphy and chronostratigraphy; Archaean cratonic nuclei of Peninsular India (Dharwar, Singhbhum, and Aravalli cratons); Proterozoic mobile belts (Central Indian Tectonic Zone, Aravalli-Delhi and Eastern Ghats); Purana sedimentary basins (Cuddapah and Vindhyan); Phanerozoic stratigraphy of India- Spiti, Kashmir, Damodar valley, Kutch, Trichinopoly, Siwaliks and Indo-Gangetic alluvium.

9. Economic Geology

Properties of mineral deposits- form, mineral assemblage, texture, rockore association and relationship; magmatic, sedimentary, metamorphic, hydrothermal, supergene and weathering-related processes of ore formation; processes of formation of coal and petroleum; distribution and geological characteristics of major mineral and hydrocarbon deposits of India.

10. Hydrogeology

Groundwater occurrence and aquifer characteristics, porosity, permeability, hydraulic conductivity, transmissivity; Darcy's Law in homogenous and heterogeneous media; Bernoulli equation, Reynold's number; composition of groundwater; application of H and O isotopes in groundwater studies; artificial recharge of groundwater.

11. Current Trends and Recent Advancement in the field of Geology.

**Syllabus of Main Examination for
Hydrologist**

પ્રશ્નપત્ર-૧ :ગુજરાતી (મુખ્ય પરીક્ષા)

ગુણ:૧૦૦

માધ્યમ:ગુજરાતી

સમય: ૨ કલાક

| અનુક્રમ | અભ્યાસક્રમની વિગત | ફાળવાયેલ ગુણ |
|---------|--|-----------------|
| ૧. | નિબંધ : ત્રણ પૈકી કોઈપણ એક (આશરે ૨૫૦ થી ૩૦૦ શબ્દોમાં) (વર્ણનાત્મક/વિશ્લેષણાત્મક/ ચિંતનાત્મક/સાંપ્રત સમસ્યા પર આધારિત). | ૨૦ |
| ૨. | વિચાર વિસ્તાર (બે પૈકી કોઈપણ એક) કાવ્યપંક્તિઓ કે ગદ્યસૂક્તિનો વિચારવિસ્તાર (આશરે ૧૦૦ શબ્દોમાં) | ૧૦ |
| ૩. | સંક્ષેપીકરણ : આપેલા ગદ્યખંડમાંથી આશરે ૧/૩ ભાગમાં તમારા શબ્દોમાં સંક્ષેપ | ૧૦ |
| ૪. | ગદ્યસમીક્ષા: આપેલા ગદ્યખંડના આધારે પૂછેલા પ્રશ્નોના જવાબ લખો. | ૧૦ |
| ૫. | ચર્ચાપત્ર (આશરે ૨૦૦ શબ્દોમાં) (વર્તમાનપત્રમાં પ્રજાના પ્રશ્નો/સાંપ્રત સમસ્યાઓ/વ્યક્તિગત અભિપ્રાય રજૂ કરતુ ચર્ચાપત્ર) | ૧૦ |
| ૬. | અહેવાલ લેખન (આશરે ૨૦૦ શબ્દોમાં) | ૧૦ |
| ૭. | દ્રશ્ય આલેખન (ચિત્ર પરથી લખાણ આશરે ૧૫૦ શબ્દોમાં) (આલેખ/ચિત્ર/ફ્લો ચાર્ટ/સરખામણી પત્રક/આંકડાકીય માહિતી વગેરે) | ૧૦ |
| ૮. | ભાષાંતર : અંગ્રેજીમાંથી ગુજરાતીમાં અનુવાદ | ૧૦ |

સૂચવ્યા મુજબ જવાબ લખો. (આ પ્રશ્નોમાં આંતરિક વિકલ્પો રહેશે નહીં.)

૧) રૂઢિપ્રયોગોના અર્થ અને તેનો વાક્યપ્રયોગ

૨) કહેવતોનો અર્થ

૩) સમાસનો વિગ્રહ કરી તેની ઓળખ

૪) છંદ ઓળખાવો

૫) અલંકાર ઓળખાવો

૬) શબ્દસમૂહ માટે એક શબ્દ

૭) જોડણી શુદ્ધિ

૮) લેખન શુદ્ધિ/ભાષા શુદ્ધિ

૯) સંધિ - જોડો કે છોડો

૧૦) વાક્યરચનાના અંગો/ વાક્યના પ્રકાર/ વાક્ય પરિવર્તન

Paper-2: English (Main Examination)**Marks-100****Medium: English****Time: 2 Hours**

| Serial No. | TYPE OF QUESTION | Marks to be allotted |
|-------------------|---|-----------------------------|
| 01 | ESSAY (A minimum of 250 words and a maximum of 300 words): Choose any one topic from a list of five. (Descriptive/ analytical/ philosophical/ based on Current Affairs) | 20 |
| 02 | LETTER WRITING (in about 150 words): A formal letter expressing one's opinion about an issue. The issues can deal with daily office matters/ a problem that has occurred in the office/ an opinion in response to one sought by a ranked officer/issues pertaining to recent concern etc. | 10 |
| 03 | REPORT WRITING (in about 200 words): A report on an official function/event/field trip/survey etc. | 10 |
| 04 | WRITING ON VISUAL INFORMATION (in about 150 words):A report on a graph/image/ flow chart/table of comparison/ simple statistical data etc. | 10 |
| 05 | FORMAL SPEECH (in about 150 words): A speech (in a formal style) that is to be read out in a formal function. This could be an inauguration speech, an educational seminar/conference, a formal ceremony of importance etc. | 10 |
| 06 | PRECIS WRITING: A precis in about 100 words for a 300-word passage. | 10 |
| 07 | READING COMPREHENSION: A reading passage of about 250 words to be given followed by short-answer type questions. | 10 |

| | | |
|----|---|----|
| 08 | ENGLISH GRAMMAR: | 10 |
| | a. Tenses | |
| | b. Voice | |
| | c. Narration (Direct-Indirect) | |
| | d. Transformation of sentences | |
| | e. Use of Articles and Determiners | |
| | f. Use of Prepositions | |
| | g. Use of Phrasal verbs | |
| | h. Use of idiomatic expressions | |
| | i. Administrative Glossary | |
| | j. Synonyms/Antonyms | |
| 09 | TRANSLATION: | 10 |
| | Translation of a short passage (of about 150 words) from Gujarati to English. | |

Paper-3: Geology I (Main Examination)**Marks-200****Medium: English****Time: 3 Hours****The structure of the question paper shall be as below:-**

| No. of Questions | Marks allotted to each Questions | Word limit for each answer | Total Marks |
|------------------|----------------------------------|----------------------------|-------------|
| 12 | 5 | 40 to 50 | 60 |
| 8 | 10 | 80 to 90 | 80 |
| 4 | 15 | 130 to 140 | 60 |

1. Physical geology and remote sensing

Evolution of Earth; Earth's internal structure; earthquakes and volcanoes; principles of geodesy, isostasy; weathering- processes and products; geomorphic landforms formed by action of rivers, wind, glaciers, waves and groundwater; features of ocean floor; continental shelf, slope and rise; concepts of landscape evolution; major geomorphic features of India-coastal, peninsular and extrapeninsular.

Electromagnetic spectrum; electromagnetic bands in remote sensing; spectral signatures of soil, rock, water and vegetation; thermal, near infra-red and microwave remote sensing; digital image processing; LANDSAT, IRS and SPOT characteristics and use; aerial photos-types, scale, parallax, relief displacement; elements of image interpretation.

2. Structural geology

Principles of geological mapping; kinematic and dynamic analysis of deformation; stress-strain relationships for elastic, plastic and viscous materials; measurement of strain in deformed rocks; structural analysis of fold, cleavage, boudin, lineation, joint, and fault; stereographic projection of linear and planar structures; superposed deformation; deformation at microscaledynamic and static recrystallisation, controls of strain rate and temperature on development of microfabrics; brittle and ductile shear zones; time relationship between crystallisation and deformation, calculation of paleostress.

3. Sedimentology

Classification of sedimentary rocks; sedimentary textures- grain size, roundness, sphericity, shape and fabric; quantitative grain size analysis; sediment transport and deposition- fluid and sediment gravity flows, laminar and turbulent flows, Reynold's number, Froude

number, grain entrainment, Hjulstrom diagram, bed load and suspension load transport; primary sedimentary structures; penecontemporaneous deformation structure; biogenic structures; principles and application of paleocurrent analysis; composition and significance of different types of sandstone, limestone, banded iron formation, mudstone, conglomerate; carbonate diagenesis and dolomitisation; sedimentary environments and facies- facies models for fluvial, glacial, deltaic, siliciclastic shallow and deep marine environments; carbonate platforms- types and facies models; sedimentation in major tectonic settings; principles of sequence stratigraphy- concepts and factors controlling base level changes, parasequence, clinoform, systems tract, unconformity and sequence boundary.

4. Paleontology

Fossil record and geological time scale; modes of preservation of fossils and concept of taphonomy; body- and ichno-fossils, species concept, organic evolution, Ediacara Fauna; morphology and time range of Graptolites, Trilobites, Brachiopods, Lamellibranchs, Gastropods, Cephalopods, Echinoids and Corals; evolutionary trends in Trilobites, Lamellibranchs, Gastropods and Cephalopods; micropaleontology- methods of preparation of microfossils, morphology of microfossil groups (Foraminifera, Ostracoda), fossil spores, pollen and dinoflagellates; Gondwana plant fossils and their significance; vertebrate life through ages, evolution in Proboscidea, Equidae and Hominidae; applications of paleontological data in stratigraphy, paleoecology and paleoclimatology; mass extinctions.

5. Stratigraphy

Principles of stratigraphy- code of stratigraphic nomenclature of India; lithostratigraphy, biostratigraphy, chronostratigraphy and magnetostratigraphy; principles of stratigraphic correlation; characteristics of Archean granitegreenstone belts; Indian stratigraphy- geological evolution of Archean nuclei (Dharwar, Bastar, Singhbhum, Aravalli and Bundelkhand); Proterozoic mobile belts- Eastern Ghats Mobile Belt, Southern Granulite Terrain, Central Indian Tectonic Zone, Aravalli-Delhi Belt, North Singhbhum Mobile Belt; Proterozoic sedimentary basins (Cuddapah and Vindhyan); Phanerozoic stratigraphy- Paleozoic (Spiti, Kashmir and Kumaon), Mesozoic (Spiti, Kutch, Narmada Valley and Trichinopoly), Gondwana Supergroup, Cenozoic (Assam, Bengal basins, Garhwal-Shimla Himalayas); Siwaliks; boundary problems in Indian stratigraphy.

6. Current Trends and Recent Advancements in the above fields.

Paper-4: Geology II (Main Examination)**Marks-200****Medium: English****Time: 3 Hours****The structure of the question paper shall be as below:-**

| No. of Questions | Marks allotted to each Questions | Word limit for each answer | Total Marks |
|------------------|----------------------------------|----------------------------|-------------|
| 12 | 5 | 40 to 50 | 60 |
| 8 | 10 | 80 to 90 | 80 |
| 4 | 15 | 130 to 140 | 60 |

1. Mineralogy

Symmetry, motif, Miller indices; concept of unit cell and Bravais lattices; 32 crystal classes; types of bonding, Pauling's rules and coordination polyhedra; crystal imperfections- defects, twinning and zoning; polymorphism, pseudomorphism, isomorphism and solid solution; physical properties of minerals; polarising microscope and accessory plate; optical properties of minerals- double refraction, polarisation, pleochroism, sign of elongation, interference figure and optic sign; structure, composition, physical and optical properties of major rock-forming minerals- olivine, garnet, aluminosilicates, pyroxene, amphibole, mica, feldspar, clay, silica and spinel group.

2. Geochemistry and isotope geology

Chemical composition and characteristics of atmosphere, lithosphere, hydrosphere; geochemical cycles; meteorites- types and composition; Goldschmidt's classification of elements; fractionation of elements in minerals/rocks; Nernst's partition coefficient (compatible and incompatible elements), Nernst-Berthelot partition coefficient and bulk partition coefficient; Fick's laws of diffusion and activity composition relation (Roult's and Henry's law); application of trace elements in petrogenesis; principles of equilibrium and Rayleigh fractionation; REE patterns, Eh and pH diagrams and mineral stability.

Half-life and decay equation; dating of minerals and rocks with potassium-argon, rubidium-strontium, uranium-lead and samarium-neodymium isotopes; petrogenetic implications of samarium-neodymium and rubidium-strontium systems; stable isotope geochemistry of carbon, oxygen and sulphur and their applications in geology; monazite chemical dating.

3. Igneous petrology

Viscosity, temperature and pressure relationships in magmas; IUGS classification of plutonic and volcanic rocks; nucleation and growth of minerals in magmatic rocks, development of igneous textures; magmatic evolution (differentiation, assimilation, mixing and mingling); types of mantle melting (batch, fractional and dynamic); binary (albite-anorthite, forsterite-silica and diopside-anorthite) and ternary (diopside-forsterite-silica, diopside-forsterite-anorthite and nepheline-kalsilite-silica) phase diagrams and relevance to magmatic crystallization; petrogenesis of granites, basalts, ophiolite suite, komatiites, syenites, boninites, anorthosites and layered complexes, and alkaline rocks (carbonatite, kimberlite, lamproite, lamprophyre); mantle metasomatism, hotspot magmatism and large igneous provinces of India.

4. Metamorphic petrology

Limits and physico-chemical controls (pressure, temperature, fluids and bulk rock composition) of metamorphism; concept of zones, facies, isograds and facies series, geothermal gradients and tectonics of orogenic belts; structures, micro-structures and textures of regional and contact metamorphic rocks; representation of metamorphic assemblages (ACF, AKF and AFM diagrams); equilibrium concept in thermodynamics; laws of thermodynamics, enthalpy, entropy, Gibb's free energy, chemical potential, fugacity and activity; tracing the chemical reactions in P-T space, phase rule and mineralogical phase rule in multi-component system; Claussius-Clapeyron equation and slopes of metamorphic reactions; heat flow, diffusion and mass transfer; Fourier's law of heat conduction; geothermobarometry; mass and energy change during fluid-rock interactions; charnockite problem, formation of skarns, progressive and retrogressive metamorphism of pelitic, calcareous and basic rocks; P-T-t path and tectonic setting.

5. Geodynamics

Phase transitions and seismic discontinuities in the Earth; seismic waves and relation between V_p , V_s and density; seismic and petrological Moho; rheology of rocks and fluids (Newtonian and non-Newtonian liquids); rock magnetism and its origin; polarity reversals, polar wandering and supercontinent cycles; continental drift, sea floor spreading; gravity and magnetic anomalies of ocean floors and their significance; mantle plumes and their origin; plate tectonic types of plate boundaries and their inter-relationship; heat flow and heat production of the crust.

6. Environmental geology and Natural hazards

Stefan-Boltzmann equation and planetary temperature; cause and effects of global climate change; Earth's radiation budget; greenhouse gases and effect; examples of positive and negative feedback mechanisms; biogeochemical cycle of carbon; geological investigations of nuclear waste disposal sites; marginal marine environments- estuaries, mangroves and lagoons; ozone hole depletion, ocean acidification, coral bleaching, Milankovitch cycle, sea level rise, eutrophication and acid rain; environmental impacts of urbanization, mining and hydropower projects; water pollution, water logging and soil erosion; Himalayan glaciers; causes and consequences of earthquakes, volcanoes, tsunami, floods, landslides, coastal erosion, droughts and desertification; application of remote sensing and geographic information systems (GIS) in environmental management.

7. Current Trends and Recent Advancements in the above fields.

Paper-5: Geology III (Main Examination)**Marks-200****Medium: English****Time: 3 Hours****The structure of the question paper shall be as below:**

| No. of Questions | Marks allotted to each Questions | Word limit for each answer | Total Marks |
|-------------------------|---|-----------------------------------|--------------------|
| 12 | 5 | 40 to 50 | 60 |
| 8 | 10 | 80 to 90 | 80 |
| 4 | 15 | 130 to 140 | 60 |

1. Occurrence and distribution of groundwater

Origin of water on Earth; global water cycle and budget; residence time concept, geologic formations as aquifers; confined and unconfined aquifers; groundwater table mapping and piezo metric nests; porosity, void ratio, effective porosity and representative porosity range; primary and secondary porosities; groundwater zonation; specific retention, specific yield; groundwater basins; springs.

2. Groundwater movement and well hydraulics

Groundwater flow concepts; Darcy's Law in isotropic and anisotropic media and validity; water flow rates, direction and water volume in aquifers; permeability and hydraulic conductivity and ranges in representative rocks; Bernoulli equation; determination of hydraulic conductivity in field and laboratory; concept of groundwater flow through dispersion and diffusion; transmissivity and aquifer thickness.

3. Water wells and groundwater levels

Unidirectional and radial flow to a well (steady and unsteady); well flow near aquifer boundaries; methods for constructing shallow wells, drilling wells, well completion; testing wells, pumping test, slug tests for confined and unconfined aquifers; fluctuations in groundwater levels; stream flow and groundwater flows; groundwater level fluctuations; land subsidence; impact of global climate change on groundwater.

4. Groundwater exploration

Surface investigation of groundwater- geologic, remote sensing, electrical resistivity, seismic, gravity and magnetic methods; sub-surface investigation of groundwater- test drilling, resistivity logging, spontaneous potential logging, radiation logging.

5. Groundwater quality and management

Groundwater composition, units of expression, mass-balance calculations; rock water interaction (chemical equilibrium, free energy, redox reactions and cation/anion exchanges), graphic representation of chemical data; groundwater hardness, microorganisms in groundwater; water quality standards; sea-water intrusion; groundwater issues due to urbanization; solid and liquid waste disposal and plume migration models; application of isotopes (H, C, O) in groundwater; concepts of artificial recharge methods; managing groundwater resources; groundwater basin investigations and management practices.

6. Current Trends and Recent Advancements in the above fields.