**Appendix 9**

  **(M.Sc. Tech. in Applied Geology)**

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###### JAI NARAIN VYAS UNIVERSITY, JODHPUR

###### FACULTY OF SCIENCE

###### NEW CAMPUS

GUIDELINES FOR CHOICE BASED CREDIT SYSTEM:

**Definitions of Key Words:**

* 1. **Academic Year**: Two consecutive (one odd + one even) semesters constitute one academic year.
	2. **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed elective and skill courses. A student need to select **two elective papers** offered by the Department in which he/she is doing core course this shall be part of core programme during third and fourth semester. Each student has to complete **four skill courses**: two within the Department and two from other Department within JNV University or the Universities approved by JNV University
	3. **Course**: Usually referred to, as ‘papers’ is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ project work/ self-study etc. or a combination of some of these.
	4. **Credit Based Semester System (CBSS)**: Under the CBSS, the requirement for awarding a degree is prescribed in terms of number of credits tobe completed by the students.
	5. **Credit Point**: It is the product of grade point and number of credits for a course.
	6. **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one period of teaching (lecture or tutorial) or two periods of practical work/field work per week.
	7. **Cumulative Grade Point Average (CGPA)**: It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
	8. **Grade Point**: It is a numerical weight allotted to each letter grade on a 10-point scale.
	9. **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.
	10. **Programme**: An educational programme leading to award of the Postgraduate Degree in the Core subject in which he/she is admitted.
	11. **Semester Grade Point Average (SGPA)**: It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.
	12. **Semester**: Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be scheduled from July to November/ December and even semester from December/January to May.

**Odd semester University examination shall be during second/third week of December and even semester University examination shall be during second/third week of May. Each Department shall conduct the Practical examinations of Odd semester with internal examiners only; however during even semester one Examiner shall be from other University/Institute**.

* 1. **Transcript or Grade Card or Certificate:** Based on the grades earned, a statement of gradesobtained shall be issued to all the registered students after every semester. This statement will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester

**Fairness in Assessment**

Assessment is an integral part of system of education as it is instrumental in identifying and certifying the academic standards accomplished by a student and projecting them far and wide as an objective and impartial indicator of a student’s performance. Accordingly the Faculty of Science resolves the following:

1. All internal assessments shall be open assessment system only and that are based on Quizzes, term test, seminar
2. Attendance shall carry the prescribed marks in all papers and Practical examination internal assessment
3. In each semester three out of four theoretical component University examination shall be undertaken by external examiners from outside the university conducting examination, who may be appointed by the competent authority

**Grievances and Redressal Mechanism**

1. The students will have the right to make an appeal against any component of evaluation. Such appeal has to be made to the Head/Principal of the College or the Chairperson of the University Department concerned as the case may be clearly stating in writing the reason(s) for the complaint / appeal.
2. The appeal will be assessed by the Chairman and he/she shall place before the **Grievance Redressal Committee (GRC),** Chaired by the Dean, Faculty of Science comprising all HODs of the Faculty and if need be Course Teacher(s) be called for suitable explanation; GRC shall meet at least once in a semester and prior to CCA finalization.
3. The Committee will consider the case and may give a personal hearing to the appellant before deciding the case. The decision of the Committee will be final.

Table 1: Grades and Grade Points

|  |  |  |  |
| --- | --- | --- | --- |
| S.No. | Letter Grade | Meaning | Grade Point |
| 1 | ‘O’ | Outstanding | 10 |
| 2 | ‘A+’ | Excellent | 9 |
| 3 | ‘A’ | Very Good | 8 |
| 4 | ‘B+’ | Good | 7 |
| 5 | ‘B’ | Above Average | 6 |
| 6 | ‘C’ | Average | 5 |
| 7 | ‘P’ | Pass | 4 |
| 8 | ‘F’ | Fail | 0 |
| 9 | ‘Ab’ | Absent | 0 |

1. A student obtaining Grade F shall be considered failed and will be required to reappear in the examination.
2. For noncredit courses (Skill Courses) ‘Satisfactory’ or “Unsatisfactory’ shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA

**Grade Point assignment**

= and > 95 % marks Grade Point 10.0

90 to less than 95 % marks Grade Point 9.5

85 to less than 90 % marks Grade Point 9.0

80 to less than 85 % marks Grade Point 8.5

75 to less than 80 % marks Grade Point 8.0

70 to less than 75 % marks Grade Point 7.5

65 to less than 70 % marks Grade Point 7.0

60 to less than 65 % marks Grade Point 6.5

55 to less than 60 % marks Grade Point 6.0

50 to less than 55 % marks Grade Point 5.5

45to less than 50 % marks Grade Point 5.0

40 to less than 45 % marks Grade Point 4.5

35 to less than 40 % marks Grade Point 4.0

**Computation of SGPA and CGPA:**

1. The SGPA is the ratio of sum of the product of the number of credits with the gradepoints scored by a student in all the courses taken by a student and the sum of thenumber of credits of all the courses undergone by a student,

 i.e

**SGPA** (Si) = Σ(Ci x Gi) / ΣCi

whereCi is the number of credits of the ith course and Gi is the grade point scored by thestudent in the ith course.

1. The CGPA is also calculated in the same manner taking into account all the coursesundergone by a student over all the semesters of a programme,

i.e.

**CGPA =** Σ(Ci x Si) / Σ Ci

where Si is the SGPA of the ith semester and Ci is the total number of credits in thatsemester.

1. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in thetranscripts.

***Illustration* for SGPA**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.No.** | **Course**  | **Credit** | **Grade letter** | **Grade point** | **Credit Point**(Credit x Grade) |
| **1** | Course 1 | **4** | **B** | **8** | **4 x 6 =24** |
| **2** | Course 2 | **4** | **B+** | **7** | **4 X 7 =28** |
| **3** | Course 3 | **4** | **B** | **6** | **4X 6 = 24** |
| **4** | Course 4 | **4** | **O** | **10** | **4 X 10 =40** |
| **5** | Course 5-Practical I | **4** | **C** | **5** | **4 X 5 =20** |
| **6** | Course 6 – Practical II | **4** | **B** | **6** | **4 X 6 = 24** |
|  | Total | **24** |  |  | **24+28+24+40+20+24 =160** |

Thus, **SGPA =160/24 =6.67**

***Illustration* for CGPA**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Semester- I** | **Semester-II** | **Semester-III** | **Semester-IV** |
| **Credit** | **24** | **24** | **24** | **24** |
| **SGPA** | **6.67** | **7.25** | **7** | **6.25** |

**CGPA = (24X6.67+ 24X 7.25 + 24X7 + 24 X 6.25)/ 96**

 **652.08/96 = 6.79**

The Department is free to distribute the Periods between Theory/Tutorial/Practical as per the Course content and the need of the course. However the selection shall be from any one of the following pattern

4 : 0 : 0 (four lectures only (no tutorial and no practical) per week).

2 : 1 : 1 (two lectures, one tutorial, and one practical per week).

0 : 2 : 2 (no lecture, two tutorials, and two practicals per week).

1 : 2 : 1 (one lecture, two tutorials, and one practical per week).

2 : 2 : 0 (two lectures, two tutorials, and no practical per week).

0 : 4 : 0 (no lecture, four tutorials only, and no practical per week).

1 : 1 : 2 (one lecture, one tutorial, and two practicals per week).

2 : 0 : 2 (two lectures, no tutorial, and two practicals per week).

0 : 0 : 4 (no lecture, no tutorial, and four practicals only per week).

1 : 0 : 3 (one lecture, no tutorial, and three practicals per week).

3 : 1 : 0 (three lectures, one tutorial, and no practical per week).

0 : 1 : 3 (no lecture, one tutorial, and three practicals per week).

1 : 3 : 0 (one lecture, three tutorials, and no practical per week).

3 : 0 : 1 (three lectures, no tutorial, and one practical per week).

0 : 3 : 1 (no lecture, three tutorials, and one practical per week).

**The Duration of the Period shall be forty five minutes. In each of these combinations, the first value stands for the same number of lecture instructions per week, whereas the last two values stand for double the number of tutorial / practical instructions per week**.

**In each practical group the number of students that can be accommodated will be decided by the respective Department Council; the general/existing pattern is 15 to 20 students in each group. The workload is to be computed accordingly.**

**Course Evaluation (Evaluation of the Students)**

All courses (Core/ Elective) involve an evaluation system of students that has the following two components:-

* 1. **Continuous Comprehensive Assessment (CCA)** accounting for 30% of the final grade that a student gets in a course; and
	2. **End-Semester Examination (ESE)** accounting for the remaining 70% of the final grade that the student gets in a course.
1. **Continuous Comprehensive Assessment (CCA)**: This would have the following components:
	1. **Quizzes:** Two Quiz examinations of 45 minutes duration each having a maximum of 40 marks shall be arranged for theory paper during the semester course period
	2. **Term Test**: One term test shall be arranged for each theory paper prior to End-Semester Examination; examination duration shall be of three hours; maximum marks is 70
	3. **Seminar**: Each student shall prepare and deliver a seminar per theory paper; maximum marks shall be 15. The seminar shall commence after first quiz examination and shall be completed prior to term test for all the papers.
	4. **Classroom Attendance –** Each student will have to attend a minimum of 75% Lectures / Tutorials / Practicals. A student having less than 75% attendance will not be allowed to appear in the End-Semester Examination (ESE). Attendance shall have 15 marks and will be awarded by following the system proposed below:

Those having greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:-

75% to 80% = 3 marks

80% to 85% = 6 marks

85 to 90% = 9 marks

90% to 95% = 12 marks

˃ 95% = 15 marks

**All students’cumulative attendance shall be displayed in the Department Notice Board every month with a copy to the Dean, Faculty of Science.**

* 1. CCA are based on open evaluation system without any bias to any student
	2. Any grievance received in the Department from student shall be placed before the **Grievance Redressal Committee** with adjudicated comments

Each component marks will be added without rounding and the total thus obtained is ratio by a factor of six. This value shall be rounded.

Illustration : Quiz 1 – Marks obtained = 30

 Quiz 2 – Marks obtained = 35.5

 Term Test Marks obtained = 50.5

 Seminar Marks obtained = 14

 Attendance Marks obtained = 9

 Total = 139.00

 Conversion = 139/6 = 21.16666

 Award = 22.00

**Skill Course Evaluation:** Based on his/her performance and hands on practice, the respective Department shall declare the result as “Satisfactory” or “Non-Satisfactory”; each student need to get a minimum of three “Satisfactory” declaration for the course completion

**In laboratory courses (having only practical (*P*) component**), the CCA will be based on students attendance (50%); hands on Practical in physical science stream (50%) and collection of biological material (25%) and hands on Practical (25%) in biological and earth science stream.

**For QUIZ** (2 quizzes per semester), 40 marks per Quiz and total of 80 marks, 45 minutes duration for each quiz:

|  |  |  |  |
| --- | --- | --- | --- |
| Types of question | Number of Questions | MarksPer question | Total marks per type |
| 1. Multiple choice
2. Fill in the blanks
3. Short answer (15 words)
 | 10105 | 122 | 102010 |
| Total | 25 |  | 40 |

**For the Term test and ESE**:

**Part A**

Ten short type questions (Definitions, functions, short explanations, etc) for two marks each. 10 × 2= 20 marks; two questions from each Unit; no choice in this part

**Part B**

Five short answer (250 words) type questions for four marks each. 5 × 4 = 20 marks; one question from each Unit with internal choice

**Part C**

Five questions of long/explanatory Answer (400 words) type, one drawn from each Unit; student need to answer any three; ten marks each; 3 × 10 = 30 marks

**20+20+30 = 70 marks**

**Qualifying for Next semester**

* + 1. **A student acquiring minimum of 35% in total of the CCA is eligible to join next semester**.
		2. A student who does not pass the examination (CCA+ESE) in any course(s) (or due to some reason as he/she not able to appear in the ESE, other conditions being fulfilled, and so is considered as ‘Fail’), shall be permitted to appear in such failed course(s)’in the subsequent ESE to be held in the following October / November or April / May, or when the course is offered next, as the case may be.
		3. A student who fails in one or more papers in a semester shall get three more chances to complete the same; if he/she fails to complete the same within the prescribed timei.e three additional chances for each paper;the student is ineligible for the Postgraduate degree in the Subject in which he/she is admitted. Additional chances examination fee shall be on additive basis.

**Improvement Option**:

Every student shall have the opportunity to improve Credit thorough University Examination only. Improvement opportunity for each paper is only with two additional chances; improvement examination fee shall be on additive basis; the Credit obtained in improvement examination shall be final. There shall be no improvement opportunity in Practical examinations**.**

**Result Declaration:**

The ESE (End Semester Examination/University Examination) results shall be declared within twenty days of the last examination. The Theory/ Practical Classes of even semesters shall begin from the next day of ESE; whereas odd semester classes shall commence after summer vacation.

**M.Sc. Tech Applied Geology (2019-2020)**

**M.Sc. Tech Applied Geology: Semester I**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Type of course** | **Course code** | **Title of the Course** | **Lecture-Tutorial-Practical/Week** | **No. of credits** | **Continuous Comprehensive Assessment (CCA)** | **End-Semester Examination (ESE)****[University Examination]** | **Total** |
|  |  |  |  |  |  |  |  |
| **Core course 1** | **AG 101** | **Planetary Geology**  | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 2** | **AG 102** | **Groundwater Hydrology**  | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 3** | **AG 103** | **Geo-informatics** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 4** | **AG 104** | **Geodynamics and Seismology** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course practical 1** | **AG 105** |  **Planetary Geology, Groundwater Hydrology** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Core course practical 2** |  **AG 106** | **Geo-informatics and Geodynamics and Seismology** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Skill Development Course I** |  **AG 107** | **Survey in Field**  | **2-0-2** |  |  |  |  |
|  |  |  |  | **24** | **180** | **420** | **600** |

**M.Sc. Tech Mineral Resources and Management: Semester II**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Type of course** | **Course code** | **Title of the Course** | **Lecture-Tutorial-Practical/Week** | **No. of credits** | **Continuous Comprehensive Assessment (CCA)** | **End-Semester Examination (ESE)****[University Examination]** | **Total** |
| **Core course 5** | **AG 201** | **Environmental Geology** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 6** |  **AG 202** | **Engineering Geology** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 7** |  **AG 203** | **Exploration and Mining Geology**  | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 8** | **AG 204** | **Geochemistry** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course practical 3** |  **AG 205** |  **Environmental Geology and Engineering Geology** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Core course practical 4** |  **AG 206** |  **Exploration and Mining Geology, Geochemistry** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Skill Development course II** |  **AG 207 (any one)** | 1. **Minerals and rocks**
 | **2-0-2** |  |  |  |  |
|  |  |  |  | **24** | **180** | **420** | **600** |

* 1. **Seminar**: Each student shall prepare and deliver a seminar per theory paper; maximum marks shall be 15. The seminar shall commence after first quiz examination and shall be completed prior to term test for all the papers.
	2. **Classroom Attendance –** Each student will have to attend a minimum of 75% Lectures / Tutorials / Practicals. A student having less than 75% attendance will not be allowed to appear in the End-Semester Examination (ESE). Attendance shall have 15 marks and will be awarded by following the system proposed below:

Those having greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:-

75% to 80% = 3 marks

80% to 85% = 6 marks

85 to 90% = 9 marks

90% to 95% = 12 marks

˃ 95% = 15 marks

**Each student’s cumulative attendance shall be displayed in the Department Notice Board every month with a copy to the Dean, Faculty of Science.**

Condonation of Shortage of attendance shall be governed in accordance with the provisions in the Act and Statute of the University vide Ordinance 78 to Ordinance 80 as amended from time to time.

Second addition:

**Qualifying for Next semester**

* + 1. **A student acquiring minimum of 40% in total of the CCA is eligible to join next semester**.
		2. A student who does not pass the examination (CCA+ESE) in any course(s) (or due to some reason as he/she not able to appear in the ESE, other conditions being fulfilled, and so is considered as ‘Fail’), shall be permitted to appear in such failed course(s) in the subsequent ESE to be held in the following October / November or April / May, or when the course is offered next, as the case may be.
		3. A student who fails in one or more papers in a semester shall get three more chances to complete the same; if he/she fails to complete the same within the prescribed time, i.e. three additional chances for each paper; the student is ineligible for the Postgraduate degree in the Subject in which he/she is admitted, for additional chances examination fee shall be on additive basis.

**Improvement Option**:

Every student shall have the opportunity to improve Credit thorough University Examination only. Improvement opportunity for each paper is only with two additional chances; improvement examination fee shall be on additive basis; the Credit obtained in improvement examination shall be final. There shall be no improvement opportunity in Practical examinations**.**

**Result Declaration:**

The ESE (End Semester Examination/University Examination) results shall be declared within twenty days of the last examination. The Theory/ Practical Classes of even semesters shall begin from the next day of ESE; whereas odd semester classes shall commence after summer vacation.

**Students Failed in CCA**:

Any student declared “Not Eligible” by the Department based on CCA in Semester I, II, III or IV and accordingly did not appear in ESE; can be readmitted as an additional student in that Semester in the **following year only**. Such student need to deposit the annual university fee as prescribed for that academic year.

**M. Sc. Tech Applied Geology Syllabus**

**(2019-2020)**

**SEMESTER I**

**Core PAPER AG 101: PLANETARY GEOLOGY**

**Unit I**

Supernovae, Nova, explosive nucleosynthesis, generations of stars. Origin of solar system. The Sun, Massive stars. Origin of Elements.

**Unit II**

Terrestrial Planets: Murcury, Venus, Mars and Earth. Introduction to Jupiter and Saturn and their satellites.

**Unit III**

Meteorites. Types of meteorites. Iron meteorite, chonries, achonrites, carbonaceous chondrites. Origin of meteorites. Radiometric ages. Asteroids. Impacts and their significance.

**Unit IV**

Moon and moon earth system. Lunar density and Tidal forces, Receding moon. Gravity on moon. High land, maria Lunar craters, Regoliths. Bulk composition of moon and magmatic differentiation. Internal structure of moon. Origin of moon. Comparison with Titan and Io. Lunar Missions.

**Unit V**

Earth as a Planet: Condensation of Planetary Nebulae, density, gravity, Core, Mantle and Crust. Hydrosphere and Atmosphere.

## Paper AG 102: GROUNDWATER HYDROLOGY

Unit 1

* Sources of Groundwater. The hydrologic cycle. Occurrence, movements and origin of groundwater. Vertical distribution of groundwater, zones of aeration- parched water table, zone of saturation - free and confined groundwater, comparison of surface and sub-surface storage. Darcy’s Law and its range of validity.
* Importance of meteorology in hydrologic investigations, rainfall- runoff estimation of seasonal and annual rainfall. Temperature, humidity and wind velocity. Measurement of stream flow measurement of evaporation and transpiration losses.
* Hydrological properties of water bearing material. – permeability, hydraulic conductivity, transmissivity, storativity, specific yield, specific retention, hydrostatic pressure, water table slope or hydraulic gradient.
* The water table- definition, water table in granular formations, in fractures and solution opening, water table maps and pressure surface maps, fluctuation of water table, groundwater basin, mounds, trenches and cascades

**Unit 2**

* Groundwater and well hydraulics – Ground water flow- Permeability methods.
* Laboratory methods - direct and indirect, variable head and constant head methods
* Field Methods – Groundwater velocity methods- dye method, salt method, electrolyte method, discharging well method, drawdown method,

- Equilibrium method - Thiem method,

- Non-equilibrium methods - Theis Method, Cooper and Jacob Method, Chow Method;

- Recovery Method- Theis Recovery Method.

# Unit 3

* The construction of water wells – shallow well and deep wells.
* Types of wells - inverted wells, recharge wells, radial wells, drill wells, dug wells dug cum bore wells and open wells, infiltration galleries, collector wells.
* Development of wells - Different methods of development of wells, fundamental principles governing performance of wells, relation of drawdown to yield, relation of diameter to yields, specific capacity of wells and efficiency of wells step drawdown test.
* The completion of wells or design of wells - relation of slot openings to mesh sizes and gauge number. Corrosion of wells and encrustation of well screen
* Gravel treatment of wells - basic principles of gravel treatment, hydraulics of gravel treated wells, development and pumping of gravel treated wells,
* Testing wells for yield, protection of wells.

**Unit 4**

* Impurities and treatment of natural water- origin of impurities in natural water, quality of water – physical, chemical, biological and radiological characteristics. Importance of quality in ground water.
* Ground water suitability for drinking, irrigation and industrial purposes. Ground water pollution their sources and causes, treatment of ground water- increasing and decreasing hardness removal of impurities chlorination, removal of dissolved material. Saline water intrusion in aquifers.

**Unit 5**

* Surface and subsurface geophysical and geological methods of groundwater exploration hydro-geomorphic mapping using various remote sensing techniques.
* Radio isotopes and hydro-geological studies
* Basin wide ground water development, conjunctive use of surface and ground water. Groundwater development assessment and management.
* Groundwater modelling.
* Artificial recharge of ground waters, problems of over exploitation, groundwater legislation.

**Paper AG 103: GEOINFORMATICS**

**Unit 1.**

* **Introduction & scope of photo geology-** types and acquisition of aerial photographs, their geometric characteristics, scale, factors affecting scale & aerial photography, mosaics, film and filter combination, aerial cameras & flying agencies.
* **Stereoscopy-** lens and mirror stereoscope, stereovision, pseudo stereovision, vertical exaggeration, image displacement, parallax and various distortions, measurement & their removal, instrumentation for interpretation, plotting and measurement.
* **Basic elements of photo interpretation**- recognition and interpretation of aeolian, glacial, fluvial and marine landforms in igneous, sedimentary and metamorphic terrain.

**Unit 2.**

 **Introduction & scope of remote sensing-** Earth Resources Technology Satellites (ERTS), LANDSAT, SPOT & IRS mission, Meteorological and Ocean Monitoring Satellites.

* **Remote Sensing-** principles­, electromagnetic spectrum and atmospheric windows, EMR quantities, radiation laws, interactions with atmosphere and terrain objects, Platforms and sensors**-** multispectral scanners (MSS) & scanning modes.
* **Types of remote sensing-** thermal & microwave remote sensing, scale & resolutions, interpretation ofpanchromatic, black & white, false colour composites (FCC), coloured infrared, thermal infrared, radar, MSS and hyper spectral imageries, spectral signature

**Unit 3.**

* **Concept of digital images and data formats-** preprocessing, enhancement, classification algorithms and accuracy assessment, satellite data reception, product generation and ordering procedure.
* **Geographic Information System-** hardware and software requirements, GIS packages, recent trends and developments.
* **Spatial data models-** data qualities and sources of errors, inputting, editing and topology creation, coordinate system**-** datum and projections

**Unit 4.**

* **Spatial analysis-** Digital Elevation Model (DEM), Triangular Irregular Network model and other models & their applications; network analysis.
* **Applications of GIS-** in geological, geomorphological, hydrogeological, engineering geological surveying and mapping.

**Unit 5.**

* **Survey & mapping-** of Soil, agriculture, forest, land use & land cover. Ecosystem analysis & biodiversity management, coastal zone management and oceanography, high resolution satellite images and human settlement analysis.
* **GPS-** components, positioning and corrections, navigation principles, differential GPS, other navigation systems, surveying methods & integration with GIS themes.

**Paper AG 104: GEODYNAMICS AND SEISMOLOGY**

**UNIT I**

Continental drift: Super continents, Gondwana land and its break up, Geophysical Evidences for continental drift and drift of India, Indian Ocean floor its evolution and active lithospheric processes. Plate Tectonics: The lithosphere, Distribution of Plates, Major and Minor plates, Kinds of Plate Margins-Constructive, destructive and conservative plates, Characteristics and processes at accreting and consuming plate boundaries, Stability and stress distribution with in plates, active and passive continental margins, marginal basins, transform faults.

**UNIT II**

Differences between plate tectonics and continental Drift, magnetostratigraphy, paleomagnetism, Plate tectonics and mountain building, relative motion of the plates, Methods of measuring plate motions, Causes of plate motions, Eulers pole of rotation, Forces acting on the lithospheric plates, the Wilson cycle, Continental collisions, seismicity and Intraplate earthquakes. Eustatic movements, Evidences of sealevel changes, Global sea level changes, sea level changes during the Quaternary period, Pre-quaternary sea level changes, Mechanism of sea level change, Impact of sea level changes. Brief description of structure and composition of the oceanic and continental crusts, upper and lower mantle and core (inner and outer), Rheological effects of lithosphere, Brittle and ductile deformation, creep mechanism in the earth, Rigidity of Lithosphere, flexure of plates and compensation models in lithospheric studies. Stresses in the Lithosphere and their sources.

**UNIT III**

Convection: Mantle viscosity, Concepts of mantle convection Models, Coupling between plates and mantle convection, Hot spots and Mantle plumes, Plume generation Mechanism, Evidence for mantle plumes from seismology and Geoid, Deep Continental structure of India-Sources of data, Suggested crustal column, seismic velocity structure, Heat flow and seismicity structure, evaluation of tectonic stress, Plate tectonics and evolution of Himalayas, models based on gravity, DSS data and seismicity (Brief description only).Introduction to seismology. Earthquakes and Plate Tectonics: Plate kinematics, Spreading centers, and Subduction zones. Oceanic interplate seismicity, Continental earthquakes and tectonics. Faulting and Fracture, Secondary effects of earthquakes: landslides, tsunami, fires and fatalities, Seismicity of India and Globe, Seismic zoning. Earthquake effects and hazards. Elastic waves- Elastic, Anelastic and Plastic behavior of materials. Stress, Strain, elastic constants. Seismic waves- Introduction, Body waves. Surface Waves, Types and Phases of waves. Free oscillations of the Earth, the internal Structure of the Earth- Refraction and Reflection in the earth's interior. Types of Earthquakes.

**Unit IV**

Seismometry: Introduction, Principle of Seismometer, Vertical motion seismometer, and Horizontal motion seismometer. Broad Band seismometer, Analog recorders. Digital recorders, Seismogram- Identification of Phases on a seismogram. Selection of seismograph stations. Global seismic network**.** Seismic Sources - Faults, Introduction of earthquake focal mechanism, Single- Couple and Double couple radiation patterns. Fault-plane solutions. Mechanics of faulting, Travel-Time curves, locating earthquakes.

**Unit V**

Seismogram Interpretation, Earthquake intensity Magnitude, Frequency, Energy released in an earthquake. Epicenter determination. Analysis of earthquake focal Mechanism. Micro earthquakes- Analysis and interpretation of seismograms, Reservoir induced earthquakes. Prediction of location of the earthquake. Earthquake control. Monitoring of Nuclear explosions.

**AG 105 : Core Practical 1:**

**PLANETARY GEOLOGY, GROUNDWATER HYDROLOGY**

**AG 106: Core Practical 2:**

 **GEO-INFORMATICS AND GEODYNAMICS AND SEISMOLOGY**

**AG 107: SKILL DEVELOPMENT COURSE:**

 **Survey in Field**

1. Principles of surveying. Survey equipments.
2. Radial method of plane table survey.
3. Plane table survey with intersection methods.
4. Pace/Tape and compass methods survey with theodolite with various applications.

**SEMESTER II**

**Paper: AG 201 : ENVIRONMENTAL GEOLOGY**

**Unit - I**

Concepts of Environmental Geology – it's scope, objectives and aims; Application of Geology to Sustainable Development. Terrain evaluation and Land-use planning; Geological causes of Environmental degradation - lithological, structural, geomorphological and also anthropogenic causes. Pollution due to waste disposals. Introduction to Elements of Environmental Impact Assesment. Environmental Legislations in India.

**Unit – II**

Landslides: their types; Factors controlling landslides; Landslide hazard zonation mapping; Preventive and precautionary measures of Landslides and floods; Earthquake: Distribution, magnitude and intensity of earthquakes; Seismic zonation map of India; Impact of seismic hazads on long and short term environmental conditions.

**Unit - III**

Fundamental principles and technology of aerial photography; types of aerial photographs; factors affecting aerial photography; types of camera, film and filters; scale of aerial photography and factors affecting scale; mosaics and annotation; relief displacement; vertical exaggeration. Stereoscopic parallex.

**UNIT – IV**

Concepts of remote sensing: Electromagnetic radiation – characteristics, remote sensing regions and bands. remote sensing system: space platforms and orbital patterns. Spectra of common natural objects – soil, rock, water and vegetation. Sensors: active and passive. Thermal IR remote sensing and its application. Microwave remote sensing and its application.

**UNIT – V**

Remote sensing applications in interpreting structure and tectonics, Lithological mapping and mineral resources. Landsat, Skylab and Seasat imageries and their interpretation for geological and other studies; Space research in India – Bhaskara and IRS systems and their applications. Principles and components of GIS. Application of GIS in various geological studies.

**Paper: AG 202: ENGINEERING GEOLOGY**

**Unit 1**

* **Introduction and scope** of engineering geology, geotechnical engineering and environmental geo-technology, recent trends & developments.
* **Engineering properties of rocks,** behavior under loads, stress & strain, elasticity (elastic constants), residual stresses, rock discontinuity (RQD, Q & RMR), geotechnical logging charts, engineering classifications (NGI, ISRM & CSIR), physical characters of building stones, concrete and other aggregates.
* **Engineering properties of soils-** soil profile, grading, index properties, consistency limits, influence of clay minerals, liquefaction, behavior under loads, effective, neutral and total stresses, lateral earth pressure and arching in soil, theories of failure, engineering classification, expansive pressure, consolidation and compressibility, geo-grids.

**Unit 2**

* **Dams and reservoirs-** types and classification, forces acting on the dam body, reservoir induced seismicity, investigations for the construction of dams and reservoir, spillways etc., case studies.
* **Foundation rock and abutment problems-** abatement technology, reservoir area problems (such as assessment of mineral resources, agriculture, forest, silt survey, reservoir life and rehabilitation sites), bearing strength of foundation rocks/soils and their improvement, piles, case studies.
* **Tunnels-** types, problems due to underground water and fault-shear zones, tunneling in hard and soft grounds, investigations for tunnel alignment, tunnel support design, tunnel linings, TBM, case studies.

**Unit 3**

* **Bridges–** types, abutment and foundation problems across river and valley crossing, geological investigations for construction of bridges, Case studies.
* **Canals-** types, investigations for canals, drains and linings, problems and their control, river interlinking projects in India.
* **Buildings–** foundations and their selection, types of piles, foundation problems and their improvement, power plants and pumping station on fills.
* **Aseismic designing** - earthquake mechanism, intensity, magnitude, seismicity and zoning, calculation of safety factor (seismic coefficient), earthquake resistance design, geo-radars, major earthquakes and their impact.

**Unit 4**

* **Landslides and types of mass movements–** types and classification, causes and mechanism, subsidence and settlements, investigations for soil and rock slope instability, prevention and mitigations, earthquake induced landslides, hazard zoning, case studies of Himalayas.
* **Highways and embankments–** types, investigations for the construction of highways and embankments in plain and sloping land, cut and fill excavation, classification of excavation materials, foundation problems and their control, case studies.

**Unit 5**

* **Shoreline engineering**– destruction of shorelines, planning and construction of littoral barriers; sedimentation and its control in harbours.
* **River training and flood control–** river improvement for navigation, principles of flood control, control of abutment erosion, case studies.
* **Military geology–** Applying engineering geology to military problems, organizing geological services for the army, Military Engineering-BRO.

**Paper AG 203: EXPLORATION** **AND MINING GEOLOGY**

**Unit I**

Industrial Mineral Deposits: Refractory, abrasives, ceramics and glass making materials, fertilizers, paints and pigment materials cement, materials and gemstones. Study of following with reference to origin mode of occurrence ,distribution in India and uses; mica, asbestos, pyrite, barites,g gypsum, bentonite, garnet, corundum, kaynite, sillimanite, graphite, talc, fluorite, beryl, zircon and rock phosphate.

**Unit II**

(i) Exploration : Basic aim of exploration. Classification of methods of exploration. Surface exploration and Sub Surface exploration. Aerial photography and remote sensing Interpretative characteristics of Aerial photographs and their application in identification of Geomorphology , Structures and Lithology for exploration.

 (ii) Sampling : Sampling in mining geology. Different types of samples, and their collection, Treatment and handling of samples, precautions, Ore reserves estimation, Different types of Reserves and their estimation, Calculation of grade and tonnage, Methods for averaging of assays, Elements of blasting and effect of lithological and structural features on fragmentation.

(iii) Ore guides and controls; Ore Shoots target rings and intersecting loci, Regional and local guides to ore, Physiographic guides, Lithological and stratigraphic guides, Structural guides and fracture pattern.

Mineralogical guides , Bottomming and zoning of mineral deposits.

**Unit III**

Geophysical Exploration: Variation of Gravity over the surface of the earth. Principle of gravimeters. Gravity field surveys. Various type correction applied to gravity data. Preparation of gravity anomaly maps and their interpretations in term of shape size and depth. Geomagnetic field of the earth . Magnetic properties of rocks . Working principle of magnetometers. Field surveys and data collection. Preparation of magnetic anomaly maps and their quantitative interpretation. Magnetic anomalies due to single pole and dipole. Introduction to Aeromagnetic survey. Three dimensional current flow, potential due to a point current source.

Resistivity Method: Basic principles , various type of electrode configurations, Field procedure: profiling and sounding . Applications of electrical methods in ground water prospecting and civil engineering problems.

Seismic Methods : Fundamental principle of wave propagation , refraction and reflection surveys for single interface , horizontal and dipping cases.

Concept of seismic channel and multi-channel recording of seismic data. End- on and spread shooting technique . CDP method of data acquisition , sorting , gather stacking and record section. Seismic velocity and interpretation of seismic data.

Application in mineral and petroleum exploration . Description of borehole environment. Brief outline of various well- logging techniques . Principles of electrical logging and its application in petroleum, groundwater and mineral exploration .

**Unit IV**

Geochemical explorations : Principles and methods of geochemical prospecting, methods of geochemical exploration , applicability and precautions in geochemical exploration. Pedo-,Litho-, Geo- and hydrogeochemical–explorations.

 Boring: principles of boring ; selections of sites for boreholes ; surface layout ; method of percussive (solid hollow and ropes), rotary , (diamond, chilled shot, clay and other system), details of equipments , properties of drilling mud , Core recovery wire line core barrel : interpretations of bore hole data, bore hole logging, maintenance of records , difficult boring , controlled directional drilling , deflection of boreholes, Difficulties in boring , Fishing tool and their uses.

**Unit V**

Introduction to mining terms (shaft, adit, chute, cross cut, stopping, room and pillaring, hanging and foot wall etc) and mining methods: open and underground. factors involving in selection of open cast and underground mining methods; coal mining methods: room and pillar method, long wall method.

Ore dressing and National mineral policy.

**Paper AG 204 : GEOCHEMISTRY**

Unit 1

* Introduction of Geochemistry, history, scope and present status
* Cosmochemistry, solar and stellar composition; The planet’s composition and structure; Detailed study of meteorites; Lunar rocks; Cosmic abundance pattern.
* Primary geochemical differentiation of the earth; Geochemical classification of elements; Composition and structure of the earth.

**Unit 2**

* Minor and trace elements during magmatic crystallization. Significance of REEs in igneous petrology; Salient features of pegmatites, kimberlite and carbonatite geochemistry.
* Geochemistry of sedimentary process; Goldisch stability series; Physico-chemical factors during sedimentary cycle; Products of sedimentation with special reference to clay minerals.
* Hydrosphere and atmosphere; their composition evolution and gains and losses through geological history.

**Unit 3**

* Biosphere; Its composition and significance. Biogenic deposits; Minor and trace elements in coal and petroleum.
* Metamorphism as a geochemical process; Mineralogy; Mineral stability, Metamorphic differentiation. Fate of minor and trace elements during Metamorphism.
* The geochemical cycle. A brief survey geochemical cycle of the following elements, Si, Al, Fe, U-Th & Au.

**Unit 4**

* Isotope Geochemistry; Significance of strontium isotopes in igneous petrology. The stable isotopes, Si, C, O and H.
* Geological aspects and comparative study of different methods of radiometric dating of rocks.
* Geochemical exploration- historical development and present status.
* Basic concepts; Geochemical environment, mobility, dispersion and dispersion patterns. Geochemical background, threshold and anomaly. Geochemical association and pathfinder elements. Interpretation of Geochemical anomaly; false anomalies.

**Unit 5**

* Geochemical exploration in relation to other methods of exploration; stages in geochemical survey.
* Different types of geochemical surveys; Lithogeochemical and atmogeochemical; pedogeochemical and drainage surveys; Botanical and other surveys.
* Introduction to geochemical exploration for petroleum and natural gas.
* Radiometric surveys.

**MRM 205: Core Corse Practical 1**

**Environmental Geology and Engineering Geology**

**MRM 206: Core Corse Practical 2**

 **Exploration and Mining Geology, Geochemistry**

**MRM 207: SKILL DEVELOPMENT COURSE (Any One)**

1.Introduction to minerals and rocks: common rock forming mineral.

 2. Common non silicate minerals.

 3. Igneous rocks.

 4. Sedimentary rocks

 5. Metamorphic rocks