**Appendix 6**

**(M.Sc. in Geophysics)**

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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 | Marks  Per question | Total marks per type |
| 1. Multiple choice 2. Fill in the blanks 3. Short answer (15 words) | 10  10  5 | 1  2  2 | 10  20  10 |
| 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. Geophysics (2018-2020)**

**M.Sc. Geophysics: 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** | **GP 101** | **Geodynamics** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 2** | **GP 102** | **Physics of Earth** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 3** | **GP 103** | **Seismology** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 4** | **GP 104** | **Geomagnetism** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course practical 1** | **GP 105** | **Geodynamics and Physics of Earth** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Core course practical 2** | **GP 106** | **Seismology and Geomagnetism** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Skill Development Course I** | **GP 107** | **Survey in Field** | **2-0-2** |  |  |  |  |
|  |  |  |  | **24** | **180** | **420** | **600** |

**M.Sc. Geophysics: 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** | **GP 201** | **Solid Earth Geology** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 6** | **GP 202** | **Gravity Method** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 7** | **GP 203** | **Magnetic Method** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 8** | **GP 204** | **Electric Method** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course practical 3** | **GP 205** | **Solid Earth Geology and Gravity Method** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Core course practical 4** | **GP 206** | **Magnetic Method and Electric Method** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Skill Development course II** | **GP 207 (any one)** | 1. **Minerals and rocks** | **2-0-2** |  |  |  |  |
|  |  |  |  | **24** | **180** | **420** | **600** |

**M. Sc. Geophysics: Semester III**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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** | **GP 301** | **Petroleum Geology and Geophysics** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 2** | **GP 302** | **Well loggong and Reservoir Analysis** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 3** | **GP 303** | **Seismic Methods** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 4** | **GP 304** | **Signal Processing and inversion theory** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course practical 1** | **GP 305** | **Petroleum Geology and Geophysics, Well loggong and Reservoir Analysis** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Core course practical 2** | **GP 306** | **Signal Processing and inversion theory** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Skill Development Course I** | **GP 307** | **RS and GIS for Urban and Regional Planning** | **2-0-2** |  |  |  |  |
|  |  |  |  | **24** | **180** | **420** | **600** |

**M. Sc. Geophysics: Semester IV**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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** | **GP 401** | **Remote Sensing** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 2** | **GP 402** | **Marine Geophysics** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 3** | **GP 403** | **Electromagnetic Methods (Active & Passive)** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course 4** | **GP 404** | **Mining, Groundwater and Environmet Geophysics** | **4-0-0** | **4** | **30** | **70** | **100** |
| **Core course practical 1** | **GP 405** | **Remote Sensing and Marine Geophysics** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Core course practical 2** | **GP 406** | **Electromagnetic Methods (Active & Passive) and Mining, Groundwater and Environmet Geophysics** | **0-0-8** | **4** | **30** | **70** | **100** |
| **Skill Development Course I I** | **GP 407** | **Building and Decorative stone** | **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. Geophysics Syllabus**

**(2018-2020)**

**SEMESTER I**

**Core PAPER GP 101: Geodynamics**

**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.

**UNIT II**

*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 III**

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.

**UNIT IV**

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 V**

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).

**Paper GP 102: PHYSICS OF THE EARTH**

**Unit I**:

Origin of the earth- the Universe and our galaxy, chemical evolution of galaxy formation of the earth and planets, primary differentiation of the earth. Composition of the various zones, abundance of elements in the earth, the rotation of the earth, the moon, salient concepts of plate tectonics.

**Unit II**:

The earth's gravity field, the force of gravity on the surface of the earth, the figure of the earth, Clairaut's theorem, the geometric and gravitational flatten! International gravity formula, geoid and spheroid, the gravity potent establishment of gravity bases, drift correction, reduction of gravity data, free and Bouguer anomalies, Isostasy - Pratt - Hayford, Airy - Heiskanen system anomalies.

**Unit III:**

Geochronology, Radioactive decay. Dating of rocks - potassium-argon – rubidium strontiumuranium- lead-carbon 14 methods, age of the earth. The earth's thermal properties, the basic thermal data, the measurement of terrestrial flow, calculation and analysis of heat flow rate, heat flow over the ocean floor, flow over continents, sources of heat in the earth, temperature distribution in earth. The equality of continental and oceanic heat flows, regions of anomalous flow, hot spots, relation ship of heat flow to the radioactivity of the earth.

**Unit IV:**

The atmosphere, composition - internal structure, prevailing and adiabatic lapse rates, instability of dry and moist air, geo potential, cloud classification, condensation nuclei, artificial precipitation, fundamental forces in the atmosphere, coriolis force and the geo strophic winds, monsoon systems, cyclones, anticyclones and tornadoes, air masses and fronts, jet streams, climate and climatic changes, ozone and other trace gases.

**Unit V:**

Hydrology - definition, hydrologic cycle, vertical distribution of groundwater types of aquifers, Darcy's law, porosity, permeability - laboratory measurement, well hydraulics - steady and unidirectional flow, quality of groundwater, concepts of water balance, sea water intrusion in coastal aquifers.

**Paper GP 103: SEISMOLOGY**

**Unit I:**

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 II:**

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

**Unit III:**

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 IV:**

Seismogram Interpretation, Earthquake intensity Magnitude, Frequency, Energy released in an earthquake. Epicenter determination. Analysis of earthquake focal Mechanism.

**Unit V:**

Micro earthquakes- Analysis and interpretation of seismograms, Reservoir induced earthquakes. Prediction of location of the earthquake. Earthquake control. Monitoring of Nuclear explosions.

**Paper GP 104: GEOMAGNETISM**

**Unit I:**

The main magnetic field, magnetic observatories, Instruments - proton precision magneto meter, magnetic elements, magnetic charts, the magnetic dipole, the magnetic field of an electric current, separation of magnetic fields of external and internal origin, the magnetic field of the external origin, ionosphere, magnetosphere, diurnal variations of magnetic field, Sq and L variations, magnetic storms and Aurora.

**Unit II:**

The magnetic field of the internal origin, IGRF, the dipole field, the non – dipole field, secular variation and west ward drift, magnetic fields of the Sun, Moon and planets, theories on the origin of earth's magnetic field, the permanent magnet hypothesis, Blackett's theory, the earth as a dynamo, the disc dynamo, dynamo of Lowes and Wilkinson.

**Unit III:**

Magnetic properties of rocks, dia, para and ferromagnetism, the ternary oxide system of magnetic minerals, the titanomagnetite series, the titanohematite series, other ferromagnetic minerals. Magnetic susceptibility of rocks, NRM in rocks, measuring instruments. Spinner magnetometer, Cryogenic magnetometers.

**Unit IV:**

Palaeomagnetism, remanant magnetism in rocks, TRM, DRM, CRM, VRM, hysterisis curve. Isolation of remnance, cleaning methods. AF demagnetization, thermal demagnetization, laboratory procedure, tests for stability.

**UnitV:**

Reversals of the magnetic field, polarity of the geomagnetic field, geomagnetic scale, projective method of presenting palaeomagnetic data, magnetic latitude and co - latitude, calculation of mean direction of virtual geomagnetic poles, palaeomagnetic poles, reconstruction of palaeomagnetic poles, continental drift, northward drift of India, results from different continents.

**GP 105 : Core Practical 1:**

1. **Geodynamics and Physics of Earth**

**GP 106: Core Practical 2:**

1. **Seismology and Geomagnetism**

**GP 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 GP 201 : Solid Earth Geology**

**UNIT I:** Basic assumptions in Geology, relation of geology with sciences-branches of geology-figure and dimensions of earth, structure, composition and origin of earth-Envelops of the earth-crust, mantle, core, External dynamic process- weathering, geological work of wind-weathering, erosion and denudation, cycle of erosion, transportation and deposition agents-loess, relief. Desert types.

Geological work of surface flowing water-streams, rivers, their development. River systemsmeandering, oxbow lakes, flood plains, peneplains and deltas. Geological work of underground water-permeability of rocks, types of water in rocks-classification of underground water-springs. Minerals waters-carbonate, sulphide and radioactive waters. Karst-forms, landslides, lakes and swamps, estuaries. Internal dynamic process-tectonic dislocations, neotectonics, earthquakes. Magmatism-volcanoes. Geological work of the sea-marine basins-relief features of the world, ocean floor. Temperature, salinity of seawater. Destructive work of sea-near shore accumulation forms-sedimentation in various zones of sea. Distribution of marine sediments.

**UNIT II:** Fundamental concepts in geomorphology-geomorphic processes-distribution of landformsdrainage patterns -development. Morphometric analysis of drainage basins, water sheds. Elements of hill slopes-pediment, bazadas. Landforms in relation to rock types, paleochannels, buried channels. Soils types and their classification. Evolution of major geomorphic process in India. Marine geomorphic processes, coastal morphological processes. Field and laboratory map scales, topographic maps, thematic maps, topographic and geomorphic profiles.

Structural, textural, and chemical classification and origin of igneous, metamorphic and sedimentary rocks- Petrogenisis, granitisation. Petrographic characters of pegmatites, kimberlites and gondites- Sedimentary structures- petrographic characters of conglomerate, sandstone, shale, limestones. Process of dolamitisation. Metamorphism-structural classification of shale, phyllite, schist, gneiss, marble quartzite and granulites.

**UNIT III:** Science of minerals, physical and optical properties of minerals. Classification, structure and chemistry of Feldspar, Mica, Pyroxenes, Amphiboles, Olivine, Quartz and Garnet groups. Clay minerals, genesis and chemistry of native elements. Elements of crystallography, Objectives of structural geology-composition and resolution of forces-stress, strain. Description of folds. Classification, mechanics and causes of folding. Foliation and lineation. Classification of faults, brittle and ductile structures, shearing and shear zones. Classification of unconformities. Map patterns and their uses in determination of large scale structures. Tectonic evolution of Dharwars, Eastern Ghats, Aravalis, Singhbhum and Cuddapahs. Evolution of Himalayas and tectonics. Outlines of geological mapping.

**UNIT IV:** Earth and stratified rocks-importance of stratigraphy-geological cycle and time scale. Stratigraphic nomenclature and classification. Sargur, Dharwar, Singhbhum super groups, Aravalis and Eastern Ghat Mobile Belts, Cuddapahs, Vindyan and Kurnool systems, Deccan basalts, Cretaceous formations, and quaternary formations- boundary problems in stratigraphy. Geochemical cycle, geochemical exploration methods, classification of elements. Analytical techniques for geochemical analysis. Outlines of standards preparation. Instruments and their exposure. Elements of ore petrology, characteristic features and genesis of ferrous and non-ferrous ore deposits of India. Mettalogeny, origin, migration and entrapment of petroleum deposits. Properties of source and reservoir rocks. Petroliferous basins of India- an outline. Classification of coal, ranking, and grading of coal deposits of India.

**UNIT V**: Physiography and divisions of seas and world oceans. Properties of sea water-salinity,

temperature, density. Littoral and sublittoral zones. Continental shelves, slopes, deep sea, aprons,

seamounts and guyots, abyssal plains- Mid ocean ridge system, aseismic ridges. Coral reefs and

their formation. Tectonic domains of oceans, island arcs, trenches, hotspot mechanism. Turbidity

currents and deep sea sediments, placers on the beach and shelfs, conditions for formation of

polymettalic nodules. Law of the seas. Orogency-continental drift hypothesis-breakup of continents-plate tectonics-convergent and divergent margins, eustatic changes of sea level, lithosphere. subduction, obduction and benioff zones, plate margins, mineralisation near plate margin, major and minor plates. Transform and transcurent faults, driving mechanism of the plates, convection currents, triple junction, movement of Indian subcontinent. Origin and evolution of life, fossils and their uses. Biomineralisation studies on fossils, pale ecology, oxygen and carbon isotopic studies on fossils, and analysis of paleontoiogical record for tracing plate tectonic process.

**PAPER GP 202: Gravity Method**

**Unit I**

Earth’s Gravity field, Properties of Newtonian potential, Laplace’s and Poissons’s equations, Green’s theorem, Gauss law, continuation integral, equivalent stratum, spatial and temporal variations, Principle of gravity prospecting, concept of gravity anomaly. Rock densities, factors controlling rock densities, Bouguer density, Insitu determinations, Borehole methods. Gravity prospecting instruments – Static gravimeters, Astatization, Zero-length spring, Worden & Lacoste Romberg Gravimeters.

**Unit II**

Plan of Gravity surveys – mineral exploration, oil prospecting and Geological mapping, Establishment of gravity bases, drift correction. Problems in airborne and shipborne gravimetry, horizontal and vertical accelerations, Eotvos correction. Application of gravity methods for regional geological mapping, Oil exploration – salt domes, structural traps, mineral exploration – sulphide ores, ferrous and non-ferrous ores, diamonds, placer deposits, groundwater and Engineering problems.

**Unit III**

Interpretation of gravity data – Qualitative interpretation, identification of structural features and litho contacts, two-dimensional and three-dimensional bodies - nature of anomalies. Regional and residual separation – graphical, average , grid and curve fitting methods, reliability of different types of residuals, use of filters, vertical derivative calculations, upward and downward continuation of anomalies, classical methods using continuation integral, employing harmonic analysis and Fourier Transformation.

**Unit IV**

Ambiguity in gravity interpretation, classical method of interpretation, gravity anomalies of point and line masses, circular discs, vertical cylinders, sheets, faults and rectangular slabs, Characterstics of anomalies, properties, interpretation by simple thumb rules and characteristic curves.

**Unit V**

Forward modeling of gravity anomalies of two-dimensional and three-dimensional bodies of arbitrary shape, Graticules, computer models, anomalies of two-and-half-dimensional bodies, Inversion of gravity anomalies of 2-D polygonal bodies, Automatic gravity modeling of sedimentary basins and density interfaces by Bott’s method. Modeling of gravity anomalies using linear, exponential and quadratic density contrast. Use of Fourier Transforms in Gravity interpretation, Mass estimation in gravity.

**Paper GP 203: Magnetic Method**

**UNIT I**

Earth’s main magnetic field, origin and temporal variations (outlines only), Geomagnetic elements, Vectorial representation, spatial variation, Basic concepts, Coulombs law of magnetic force and fields, magnetic moments, intensity of magnetization and induction, magnetic potential and its relation to field, units of measurement, origin of magnetic anomalies, interrelationship between different component anomalies, Poisson’s relation, Magnetic susceptibility, factors controlling susceptibility, magnetic classification of minerals and rocks, Laboratory and in-situ methods of determining susceptibility, Natural remanent magnetism, Astatic and Spinner Magnetometers, demagnetization effects,

**UNIT II**

Principle of magnetic prospecting, Instruments - Nuclear, fluxgate, Squid’s and optical pumping

magnetometers, gradient measurements, Plan of magnetic surveys in different mineral exploration programs, Magnetic data reduction, diurnal and normal corrections, IGRF, Airborne magnetometry, orientation mechanisms, survey techniques, data acquisition and reduction, Advantages and disadvantages, brief principles of ship-borne and satellite magnetometry

**UNIT III** Interpretation of magnetic data, qualitative interpretation, nature of anomalies, identification of different structural features. – Dependence of magnetic anomalies on latitude and orientation. Isolation and enhancement of anomalies using graphical, trend surface analysis, digital filtering, reduction to pole filter, derivative and continuation filters (Brief descriptions), Ambiguity in magnetic interpretation, generalized approach of interpretation.

**UNIT IV**

Magnetic anomalies (vertical and total field) of single poles and sphere, anomaly equations, profiles, properties and interpretation procedures. Similarity of magnetic anomalies of two dimensional bodies in different components – generalized equations for the magnetic anomalies of line dipoles, dykes, sheets and faults, profile shapes and interpretation by thumb rules and characteristic curves, ambiguity in interpretation of magnetized dyke, Koloumzine method, Forward modelling of magnetic anomalies: Gulatee’s rule, two dimensional and three-dimensional bodies of arbitrary shape, use of graticules, Computer models, familiarization of anomaly equations,

**UNIT V**

Principles of inversion, Inversion of magnetic anomalies of 2D polygonal bodies, magnetic anomalies of dykes and magnetic interfaces - Frequency domain interpretation: Use of Fourier transforms in magnetic interpretation with special reference to dykes and faults, end corrections, use of Hilbert transforms, Relation figures, brief interpretation procedures of MAGSAT anomalies- Application of magnetic method for regional geological mapping, oil exploration, mineral exploration, ground water and Engineering problems.

**Paper GP 204 : Electrical Methods – 1**

**Unit I**

Principle of electrical methods of prospecting – Electrical fields in Geophysics- current and potential in the Earth- equipotential lines of force –due to single point and dipole sources and line of electrodes. Distribution of current across layers of contrasting resistivities. Electrical properties of rocks and minerals – Laboratory measurements of electrical properties of rocks.

Electric conduction in rocks and minerals – electronic- ionic and dielectric. Electrochemical properties. Factors affecting the resistivity of rocks. Archies Law. Isotropy and Anisotropy. Principle of equivalence and suppression. Dar Zarrouk parameters – longitudinal conductance and transverse resistance.

**Unit II**

Self Potentials: origin- classification – electrochemical and electro-kinetic potentials – behavior.

Measurement of self potentials- equipment- field techniques. SP anomalies over different geometrical models – sphere, fault, dyke and sheet etc.. - Interpretation of SP anomalies. Potential due to a point source- dipole and line sources in homogeneous earth. Effect of inhomogeneous ground. Concept of apparent resistivity – apparent resistivity for multi-layered

earth. Principle of reciprocity. Reflection coefficient.

**Unit III**

Different types of electrode arrays: Wenner- Schlumberger - Dipole- Dipole- Half Schlumberge-,

Central Gradient etc.. Geometric factors and theoretical derivations for apparent resisitivity for

different electrode configurations. Horizontally stratified earth – concepts and assumptions. Computation of apparent resistivity model curves- Image point - numerical integration- linear filter methods. General description of multilayered earth. Resistivity methods field procedures- sounding and profiling.

**Unit IV**

Vertical Electrical Soundings – transformations of VES curves. Interpretation- indirect and direct methods of interpretation- approximate methods –curve matching – auxiliary curves – Resistivity transform function for Schlumberger and Dipole-Dipole – Relation between transform and layer parameters. Application of linear and digital filtering – iterative techniques. Direct methods of interpretation. Anisotropy and slope boundary planes – The resistivity profiling- over fault, dyke, vertical contact, Burried 2D and 3D regular geometric bodies. Comparison of different arrays in profiling applications.

**Unit V**

Induced Polarization method: Basic concepts – Sources of the induced polarization effects – Over voltage and induced polarization – Warburg impedence – Membrane polarization and Electrical polarization – Induced polarization- Induced polarization measurements: Time domain measurements – Principle, Chargebility, delay time– Frequency domain measurements- percentage frequency effect, Metal conduction factor. Relation between time-and frequency-domain IP measurements. Induced Polarization sounding and profiling – Field procedures – Noise sources – Plotting methods – Pesudo section plotting – Spectral IP – relaxation models in spectral IP – complex resistivity –electromagnetic coupling and capacitative coupling in IP - removal of EM coupling in spectral IP –Interpretation – mineral discrimination by spectral IP – Magnetic Induced Polarization (MIP) method.

**GP 205: Core Corse Practical 1**

**Solid Earth Geology and Gravity Method**

**RS 206: Core Corse Practical 2**

**Magnetic Method and Electric Method**

**GP 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

**SEMESTER III**

**GP 301 Paper I: PETROLEUMGEOLOGY AND GEOPHYSICS**

**Unit I**

Petroleum – occurrence – distribution- chemical and physical properties – Origin- various theories, source rock, organic matter – Maturation into petroleum – P&T conditions, Migration – primary and secondary**.**

**Unit II**

Reservoir – rocks – properties – Fluids, water – oil- Natural gas- properties, Traps- structural –

stratigraphic – combination, seals, sedimentary basins – cratonic – convergent and divergent

margin basins – classification, Category-1 basins of India.

**Unit III**

Gravity and Magnetic methods in petroleum exploration – surveys – Land and ocean areas –differences – data processing operations, Gravity anomalies – salt domes – stratigraphic traps. Magnetic methods – basement mapping, computer oriented methods.

**Unit IV**

Seismic data processing – outlines, preparation of seismic section, Reflection character- structure, pitfalls – migration 2D & 3D significance – velocity pull up, structure identification.

**Unit V**

Seismic stratigraphy – Unconformities – seismic sequences – reflection pattern – depositional environment – basin history – construction, Modelling concept – Reservoir parameters – forward

and inverse, direct detection – Bright spots – flat spots Gas hydrates, Coal bed methane.

**GP 302 Paper II: WELL LOGGING AND RESERVOIR ANALYSIS**

**Unit I:**

Reservoir Properties: Porosity, Permeability, Thickness, Temperature, Flow Types, Flow rates, Wire line sampling pressures, thief zones, Perforations, Leaks, Cement Repairs, Yield &

sustainability, Water Hold – up, Slippage Velocity, Repeat Formation Tester, Modular Dynamic

Tester.

**Unit II:**

Production Logs: Thermal Decay Time Log, Temperature Log, Continuous Flow Meter, Backer Flow meter, Spinner Flow meter, Manometer, Gradio-manometer, Radio Active Tracers, Multi finger Caliper-Casing Inspection tool.

**Unit III:**

Injection Wells: Injection rates, Temperature changes, Producing well behaviour, Tube Case analysis. Maintenance of well pressures through injection of fluids.

**Unit IV:**

Role of Logging in Water cut and prevention-remedies, Reperforations, Re-cementations. Zone transfers. Secondary Recovery methods.

**Unit V:**

Sustainability: Flow storages, Production planning, Re-estimation of Oil/Gas saturations in old wells using Reservoir Saturations Tool (RST) etc.

**GP 303: Paper III: SEISMIC METHODS**

**Unit –I**

Principles of elasticity: Normal strains, shearing strains, Hook’s law, Elastic moduli, wave equations, Huygen’s & Fermat’s Principles, Zeoppritz equations, refraction, reflection, critical refraction, diffraction, attenuation & absorption of seismic waves, acoustic impedance, surface waves, dispersion multiples, reflection and transmission coefficients. Elastic wave velocities of rocks: laboratory and field measurements, dynamic moduli, P and Swave velocities, anisotropy, attenuation, factors affecting velocity, different types of velocities, geometry of ray paths, refraction and reflection, horizontal layers and dipping layers, NMO and dip move out, discrete and continuous velocity changes, velocity inversion, low velocity layer, blind zone, hidden layer.

**Unit-II**

Electromagnetic geophone and its performance, damping coefficient, hydrophones, detector arrays, array response, uniform arrays, amplitude weighted arrays, distance tapered arrays, streamer, analog data acquisition, amplifiers, filters, gain control and recording types. Seismic energy sources for land and marine surveys. Dynamite thumper, dinosies, vibrosies, land air gun, pinger, boomer, sparker, airgun, water gun, vaporchoc etc. Controlled explosions, shot control, source arrays, energy content, frequency, pulse length and resolution, penetration, signatures of energy sources. Digital data acquisition, digital field system, signal flow and recording. Constituent units and modules. Telemetry systems, wireline and radio telemetry, telemetry system configuration and specifications, dynamic range of signals noise: shot generation, ambient and electrical noises, their nature and attenuation requirements. Noise survey, noise analysis, fold back experiment, optimization of parameters.

**Unit – III**

Single channel and multi channel surveys, field layouts and shooting procedures for land and marine 2D surveys, split spread and end-on spreads, CDP procedures for land and marine surveys, stacking chart. 3D surveys, 3D layouts, swath, brick, odds & evens, zig zag, button patch, full range 3D, loop survey. Marine 3D shooting: two streamer system, alternate shooting, two boat operation, circles shooting, 3D bottom cable survey, quad quad 3D, multiple streamers, static binning and dynamite binning. Refraction surveys: Field procedures, fan shooting, broad side shooting, inline profiling, long refraction profiles, reversed and unreversed profiles, marine refraction surveys, sonobuoy surveys. (VSP, shear wave data acquisition and other special surveys procedures are included in paper II along with processing and interpretation of seismic data). Reduction of refraction data, interpretation of refraction data, analysis of refraction records, interpretation of reversed and unreversed profiles, delay time methods, forward modeling, masked layers and hidden layers, reduction and interpretation of sonobuoy data, crustal seismology, engineering surveys, exploration for ground water, application in mining industry.

**Unit- IV** Reflection data processing, static and dynamic corrections, velocity determination. Preparation of seismic sections migration, analysis of analog records, automatic processing of digital seismic data, demultiplexing, TAR, velocity analysis, velocity spectra and velocity scan, automatic statics, picking, stacking, spiking deconvolution, dereverberation, whitening, time variant frequency filtering, apparent velocity filtering. AVO analysis, different methods of migration, automatic migration, wavelet processing. Seismic section plotting, display types, picking of events, marking-isochron & isopach maps, geological interpretation, application of reflection methodl exploration for oil and gas,

groundwater, coal, mineral deposits, gas hydrates, etc., engineering applications, crustal studies,

structural and stratigraphic traps, identification of geological structures like anticlines, faults, salt

domes etc; fit falls in interpretation.

**Unit-V**

hydrocarbon indicators, bright spot, seismic attributes, AVO analysis, vertical seismic profiling, equipment, configurations like deviated well, walk away, offset VSP etc., applications, 3D data processing and interpretation, visualization in an animated interactive environment. Seismic stratigraphy, geological sea level change model, depositional patterns, seismic sequence, seismic facies, reflection character, synthetic seismogram, modeling concepts, high resolution seismic surveys, shallow engineering surveys and suitable energy sources, 4C, 4D recording, seismic tomography, reservoir applications of petrophysics concepts, generation and recording of shear waves, energy sources, geophones, recording, processing, section plotting, interpretation Vp/Vs as lighology indicator, hydrocarbons, engineering applications.

**GP 304 Paper IV: SIGNAL PROCESSING AND INVERSION THEORY**

**Unit I**

Introduction, Definition of signal and noise, various signal classes such as continuous, piece wise continuous, absolute integrable, singularity, unit impulse, unit step, etc. Fourier series and

Fourier Transfors: Time and frequency domain, relations between various operations in both the

domain, Fourier Transform and its properties, Fourier Transforms of some important functions:

Rectangular, exponential functions, singularity functions and periodic functions.

**Unit II**

Time-series analysis: Discrete time signals, Correlation and convolution functions, impulse response and Transfer function spectrum of observational data: Discrete Fourier Transform (DFT), FFT, Z-Transforms, Delay properties of wavelets.

**Unit III**

Band limited signals: Properties, Sampling Theorem, Nyquist frequency, Aliasing, Sampling of band and time limited signals; Effect of sampling on spectrum and vice-versa; reproduction of continuous function from sampled data. Importance and effects of Windowing, Gibbs phenomenon, spectral leakage, various types of windows; power spectrum; Estimation of power spectrum, Wiener Khinchin theorem, use of various windows in power spectrum computation, spectrum computation via Auto-correlation and Periodogram.

**Unit IV**

Digital filtering: Design of digital filters, amplitude and phase response of various filters; onesided and two sided filters, low-pass, high pass and band-pass, optimum filters, Butter worth filter, Recursive and non-recursive filters, optimal and Weiner filters, Deconvolution and predictive deconvolution.

**Unit-V**

Inversion Theory: Introduction, Fundamentals of Inversion, Linear Inversion, Non-Linear Inversion, Incorporating prior information, Parametric Inversion, Assessing the uncertainty in inverted models.

**RS 305: Core Corse Practical 1**

**Petroleum Geology and Geophysics, Well Logging and Reservoir Analysis**

**RS 306: Core Corse Practical 2**

**Signal Processing and Inversion Theory**

**GP 307: SKILL DEVELOPMENT COURSE (Any One)**

RS & GIS for Urban and Regional Planning

1. To study the RS and GIS data
2. To study the Mapping for Urban and Regional areas
3. To study GIS Tool in Urban Planning

**SEMESTER IV**

**GP 401 Paper I: OPTICAL REMOTE SENSING**

**UNIT-1**

Fundamentals of Remote Sensing: Introduction: basic principles of remote sensing; electromagnetic spectrum; Planck’s law and wien's displacement law; concept of incoming short wave and outgoing long wave radiation: passive and active remote sensing, interaction of electromagnetic radiation with matter; interaction of electromagnetic radiation with atmosphere; selective and non-selective scattering; impact of scattering on remotely sensed data; atmospheric windows and absorption bands

**UNIT-2**

Spectral reflectance properties and Sensors: interaction of electromagnetic radiation with solids and liquids of the earth's surface; spectral reflectance curves of water, snow, clouds, and vegetation. Soils/rocks/minerals. Sensors: imaging and non-imaging sensors: radiometers, spectrometers. Spectroradiometers; Scanner dependent systems: line scan systems, array scanning systems, multispectral scanner systems: whiskbroom and pushbroom imaging systems;

circular/conical/side scanning systems: sensor characteristics - spatial resolution, spectral resolution, radiometric resolution and temporal resolution.

**UNIT -3**

Aerial photography: various types of aerial cameras and black and white films; scale, brightness, contrast of photograph; resolution of photograph - resolving power of film and camera lens; vertical and oblique aerial photographs; methods of aerial photographic surveys; parallax/relief displacement, stereophotography, mirror arid pocket stereoscopes, Photomosaic, low and high sun elevation angle photography. Color theory - primary and secondary colors; additive and subtractive color mixtures to generate colors, color code, working principle of normal and infrared color films and photographs; color composites - true, standard false color and false color composites; application of normal and infra red photographs.

**UNIT - 4**

Satellite remote sensing: Various platforms used for remote sensing data acquisition; orbits of satellites; geo-synchronous and sun-synchronous orbits; OPTICAL REMOTE SENSING SATELLITES: environmental meteorological satellites (past and present) and their sensors - GOES, Meteosat, INSAT, GMS, NOAA etc.; earth resources observation satellites (past, present and future) and their sensors - NIMB US/coastal zone color scanner, Landsat, Spot, Mos, IRS-la, Ib, Ic, Id, p2, p3, p4, p5, p6 etc. Indian remote sensing activity; future remote sensing missions of ISRO for earth observation.

**UNIT-5**

Thermal infrared remote sensing: Thermal processes and properties, radiant flux, heat transfer, atmospheric transmission, thermal properties of materials, thermal infrared signatures of various rocks and minerals, influence of water and vegetation on thermal inertia; thermal infrared sensors like infrared radiometers, working principle of thermal infrared scanner; TIMS etc.; satellites and sensors acquired and acquiring data under thermal infrared region - HCMM, NOAA-AVHRR, EOS-TERRA, EOS-AQUA, Geostationery satellite sensors etc.; characteristics of thermal infrared images, relative comparison of night and daytime thermal infrared imagery; advantage of thermal infrared remote sensing.

**GP 402: Paper II : MARINE GEOPHYSICS**

**Unit I:**

Physiography and divisions of the sea floor, continental shelves, slopes and aprons, submarine canyons and deep sea channels, sea mounts and abyssal plains, turbidity currents and submarine sedimentation, the mid oceanic ridge systems and its structure, aseismic ridges, various types of ridges in the Indian ocean region, the continental fracture system and island arcs, occurrence of offshore mineral deposits and hydrocarbons, hotspots, mineral resources of the sea: surficial deposits of the shelf and deep sea, heavy mineral placers, calcareous shells, pearl oysters, phosphorites, glauconite, barium sulfate carcretions, sand and gravel, extensions of ore deposits, hydrocarbon potential of the shelf and offshore sedimentary basins.

**Unit II:**

Geophysical instrumentation and surveys: Adaptation of geophysical instruments for marine surveys, Measurements at the sea surface and under water, geophysical equipment currently in use and board research vessels, complement of equipment on board the survey ship and layout of equipment, towing logistics, survey procedures and planning of survey lines, marine magnetometers, marine gravimeters, surface and under water gravimeters, Graf Askanian, Lacoste Romberg and vibrating string gravimeters, calculation of gravity anomalies.

**Unit III:**

Map projections: Different kinds of map projections, Position fixing at sea: long range and short range systems, integrated satellite navigation, Global Positioning System (GPS), Bathymetry: echosounding, bathymetric charts, bathymetry as an adjunct to geophysical surveys, submersibles, seabed mapping by side scan sonar, multibeam, lider and other surveys, seabed sampling, dredging and coring, marine geophysical surveys for sealed resources, site selection for production platforms, tunneling, waste disposal etc.

**Unit IV:**

Oceanic magnetic anomalies, sea floor spreading, Vine-Mathews hypothesis, geomagnetic time scale and dating the ocean floor, linear magnetic anomalies. Heat flow: Earth's internal sources of heat, transfer of heat within the earth, measurements at the ocean bottom, heat flow probes and measurements, factors affecting the Heat flow measurements in sea, oceanic heat flow, ocean ridges and ocean basins, marginal basins, rift valleys.

**Unit V:**

Objectives of marine geophysical surveys, marine geophysical surveys for sea bed resources, engineering investigations, deep sea geological mapping, delineation of continent-oceanic boundary, geological mapping in the coastal zone. Results of some rare studies. Geophysical anomalies of trenches, active and passive margins, ridges, island arcs, Large scale and small-scale structural features of the oceanic crust from seismic surveys (velocity structure)

**GP 403: Paper III: ELECTROMAGNETIC METHODS (ACTIVE & PASSIVE)**

**UNIT I**

*Basic****s***: Electromagnetic Induction, Primary-Secondary field relations, Vector Diagram- Real and Imaginary components resolving; Inductive and resistive limits, Response function, Elliptic polarization, Maxwell’s equations, Boundary conditions, Wave equation, Quasi static condition, Solution of wave equation, Plane wave characteristics, propagation of plane waves in conducting media, Wave number, Impedance, Skin depth versus effective depth, factors controlling depth penetration. *Classification of E.M. methods*: Sources used, continuous wave and pulse excitation principles, Measured components. Brief principles of solving electrodynamic problems including scale modeling. Field of large loop, magnetic dipole and electric dipole in air – frequency and Time domain approaches

**Unit II**

Field of magnetic dipole and electric dipole (both in transient and frequency domains) in homogeneous, isotropic space. Response of stratified medium to the above sources. Frequency and transient response of local conductors in homogeneous field –Sphere and Cylinder. Effect of

frequency and magnetic permeability on the secondary fields – Sphere as an example, Generalized induction parameter. Effect of overburden and Host rock on E.M. response. Methods using artificial fields: Surface low frequency methods: Principles, field procedures and various corrections, quantitative interpretation in Turam, Tilt angle and Slingram methods, Operation at low induction numbers - terrain conductivity measurements. Surface transient methods: Principles, Comparision with harmonic methods, Description of different current functions, various T-R configurations, General field procedures, Interpretation of surface transient method data.

**Unit III**

Radio wave methods: Principles, Theory and description, different equipment of VLF EM method. Interpretation of VLF EMR data - Applications. Brief principles of Ground Penetrating Radar and its applications in shallow depth investigations. Principles of EM soundings, Field procedures, Geometric versus parametric sounding, data preparation, interpretation and applications. *Methods using natural fields:*Principle of MT, Origin of Earth’s natural EM field: Magneto-telluric source field characteristics, MT field procedure and instrumentation. Cagniard’s relation, Impedance over N-layer medium. Apparent resistivity and phase, MT tensor,

**Unit IV**

MT Signal Processing. Swifts optimum rotation, Skew, Tipper, Ellipticity, coherency, Static shift, remote reference magnetotellurics, Induction arrows, Polar diagrams, 1-D, 2-D interpretation of magnetotelluric data – Applications. Principles of AMT, controlled source Audio Magnetotellurics, sea MT and AFMAG. Telluric current method: Principles and Field procedures, Telluric profiling technique, Theoretical considerations, Relative ellipse, Absolute ellipse, triangle, Polygon and amplitude ratio methods for interpretation of telluric data. Comparison of tellurics with MT.

**Unit V**

Airborne EM methods: Continuous wave systems, Different systems in operation, Airborne transient system (INPUT) description, Rigid Boom Helicopter System, passive Airborne EM systems – AFMAG and VLF, Different noises in AEM systems and methods of suppression, interpretation of AEM data and applications.Geomagnetic depth soundings: Origin and classification of long period geomagnetic Variations, separation of magnetic field of internal and external origin, normal and anomalous fields. Interpretation of Geomagnetic depth sounding data, Magnetometer array studies, principles of Ocean Bottom Electromagnetic methods.

**GP 404 Paper IV: Mining, Ground water and Environmental Geophysics**

**Unit I**

Crustal layers-upper and lower, Different elements in the crust, Precious and other useful substances in the upper crustal layers, Metallogenic provinces and periods. Classification of mineral deposits – Metallic and non metallic, Classification of metallic deposits-Ferrous and non ferrous, Base and noble metals, Sulphides, Oxides, Silicates and Carbonates, Processes of formation of mineral deposits –Igneous activity, Sedimentation, Metamorphism, Weathering and Erosion, Hydrothermal processes.

**Unit II**

Mineral deposits of India -Base metals and Ferrous metals, Geological mapping-Geophysical methods, Sulphide ores-Massive and disseminated ores-Prospecting strategies-examples, Iron ores- Strong and weak magnetic iron ores, genesis-prospecting.

**Unit III**

Manganese, Chromium, Placers-Prospecting strategies, Diamonds, Genesis of coal deposits of India - Geophysical prospecting, Logging in mineral exploration, Synergic interpretation.

**Unit IV**

Ground water occurrence – Igneous-Metamorphic and sedimentary rocks, Types of aquifers and their hydrological significance, Vertical distribution of water, surface investigations of groundwater-Geological method-Remote sensing-Hydrobotanical, Review of electrical resistivity and seismic refraction methods – Groundwater exploration, Buried channels, Sea water intrusion.

**Unit V**

Geophysics and earth’s environment, Environmental problems amenable to solution by

geophysical means, Engineering Geophysical problems, Survey procedures-modifications only for Environmental and Engineering Geophysics-Gravity, Magnetic, Seismic, Electrical and E.M, Radioactive and Geothermal surveys, Examples.

**GP 405: Core Corse Practical 1**

**Remote Sensing and Marine Geophysics**

**RS 406: Core Corse Practical 2**

**Electromagnetic Methods and Mining , Groundwater and Environment Geophysics**

**RS 407: SKILL DEVELOPMENT COURSE**

Building and Decorative Stone