**AnnamalaiUniversity**

**(Affiliated Colleges)**

**209 – B. Sc. GEOLOGY**

Programme Structure and Scheme of Examination (under TANSCHE)

(Applicable to the candidates admitted in Affiliated Colleges from the academic year 2023 -2024 onwards)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Course Code | Part | Study Components & Course Title | Credit | Hours/  Week | Maximum Marks | | |
| CIA | ESE | Total |
|  |  | SEMESTER – I |  |  |  |  |  |
| 23UTAML11 | I | Language - Tamil | 3 | 6 | 25 | 75 | 100 |
| 23UENGL12 | II | English | 3 | 6 | 25 | 75 | 100 |
| 23UGEOC13 | III | Core – I General Geology and Crystallography | 5 | 5 | 25 | 75 | 100 |
| 23UGEOC14 | Core – II Geo-statistics - I | 5 | 5 | 25 | 75 | 100 |
| 23UMATE15  23UCHEE15 | Elective – 1  Mathematics - I (Or)  Chemistry for Physical Science– I | 3 | 4 | 25 | 75 | 100 |
| 23UTAMB16  23UTAMA16 | IV | Skill Enhancement Course – 1 (NME-I) /\*  Basic Tamil – I /  Advanced Tamil - I | 2 | 2 | 25 | 75 | 100 |
| 23UGEOF17 | Foundation Course  Rudiments of Geohazards | 2 | 2 | 25 | 75 | 100 |
|  |  | Total | 23 | 30 |  |  | 700 |
|  |  | SEMESTER – II |  |  |  |  |  |
| 23UTAML21 | I | பொது தமிழ் -II: தமிழிலக்கிய வரலாறு-2/ | 3 | 6 | 25 | 75 | 100 |
| 23UENGL22 | II | General English – II | 3 | 6 | 25 | 75 | 100 |
| 23UGEOC23 | III | Core – III Palaeontology | 5 | 5 | 25 | 75 | 100 |
| 23UGEOP24 | Core – IV Crystallography and Palaeontology Practical | 5 | 5 | 25 | 75 | 100 |
| 23UMATE25 | Elective – II  Mathematics - II | 3 | 5 | 25 | 75 | 100 |
| 23UCHEE25 | Chemistry for Physical Science– II | 2 | 3 | 25 | 75 | 100 |
| 23UCHEEP1 | Chemistry Practical for  Physical science - I | 1 | 2 | 25 | 75 | 100 |
| 23UTAMB26  23UTAMA26 | IV | Skill Enhancement Course – II (NME-II) /\*  Basic Tamil – II /  Advanced Tamil - II | 2 | 2 | 25 | 75 | 100 |
| 23USECG27 | Skill Enhancement Course – III  Internet and its Applications  (Common Paper) | 2 | 2 | 25 | 75 | 100 |
|  |  | Total | 23 | 30 |  | 700/ 800 | |

**Non-Major Elective Courses (NME)to other Departments)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| IV | 23UGEON16 | Understanding the Earth | 2 | 2 | 25 | 75 | 100 |
| 23UGEON26 | Basics of Earth Science | 2 | 2 | 25 | 75 | 100 |

\* PART-IV: NME / Basic Tamil / Advanced Tamil (Any one)

Students who have not studied Tamil upto 12th Standard and have taken any Language other than Tamil in Part-I, must choose Basic Tamil-I in First Semester & Basic Tamil-II in Second Semester.

Students who have studied Tamil upto 10th & 12th Standard and have taken any Language other than Tamil in Part-I, must choose Advanced Tamil-I in First Semester and Advanced Tamil-II in Second Semester.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **Subject Name** | **Category** | **L** | **T** | **P** | **S** | **Credits** | | **Inst. Hours** | **Marks** | | | |
| **CIA** | | **External** | **Total** |
| **23UGEOC13** | GENERAL GEOLOGY AND CRYSTALLOGRAPHY | Core | Y | - | - | - | 5 | | 5 | 25 | | 75 | 100 |
| **Course Objectives** | | | | | | | | | | | | | |
| CO1 | The main objective of this course is to enumerate the origin of Earth. | | | | | | | | | | | | |
| CO2 | To describe the concepts of Dating and internal structure of the Earth | | | | | | | | | | | | |
| CO3 | To explain various components of crystals and crystallography | | | | | | | | | | | | |
| CO4 | To study various class and forms of an crystal system. | | | | | | | | | | | | |
| CO5 | To determine various crystallographic properties of crystals with suitable examples. | | | | | | | | | | | | |
| **UNIT** | **Details** | | | | | | | **No. of Hours** | | | **Course Objectives** | | |
| I | Universe – Evolution of the Universe – Stellar system – Milky Way Galaxy –Evolution of Galaxy. Solar System – Inner and outer planets – characteristics of solar system. Satellites – Asteroids – Meteors – comets. Earth – movements – revolution – rotation – solstice – equinox – time – GMT – IST. Atmosphere – Monsoon-El Nino – hydrosphere – lithosphere- Origin of the Earth – Nebular and Planetesimal hypothesis – Tidal &Vonweizacker’s hypothesis – merits and demerits of the above hypotheses | | | | | | | 12 | | | CO1 | | |
| II | Age of the Earth – old methods – new methods – Radioactivity – Half-life period – Radiometric methods – Uranium / Lead method – Rubidium / Strontium method – Lead / Lead method – Potassium/Argon -Carbon 14 method. Numerical methods in dating. Interior of the Earth – Density – Shape – Seismic waves – Composition and thickness of the crust, mantle and core. Discontinuities: Conrad Discontinuity – Mohorovicic Discontinuity – Weichert-Guttenberg Discontinuity | | | | | | | 12 | | | CO2 | | |
| III | Definition of crystal – Unit cell, Bravais Lattices, Plane groups, Point groups & Space groups - Crystallographic axes – Symmetry Elements – Division of crystals into systems and Point groups – Axial Ratio – Parameters – Indices – Miller Indices – Symbol – Hermann Mauguin notations –Law of Rational Indices – Forms – simple – combination – open – closed – unit – holohedral – hemihedral – tetrahedral – hemimorphic – enantiomorphous forms – Interfacial angle and its measurement with Contact Goniometer. Types of Goniometers | | | | | | | 12 | | | CO3 | | |
| IV | Study of common forms and combinations of the following systems and classes: Isometric System: Hexoctahedral, Diploidal, Hextetrahedral – Tetragonal System: Ditetragonal bipyramidal, Tetragonal bipyramidal, Tetragonal Pyramidal, Tetragonal Sphenoidal – Hexagonal System: Dihexagonal Bipyramidal, Hexagonal Bipyramidal Trigonal System – Ditrigonal Scalenohedral - Ditrigonal pyramidal, Trirhombohedral, Trigonal trapezohedral. | | | | | | | 12 | | | CO4 | | |
| V | Study of common forms and combinations of the following systems and classes: Orthorhombic System: Rhombic Bipyramidal, Rhombic pyramidal, Rhombic Disphenoidal – Monoclinic System: Prismatic – Triclinic System: Pinacoidal – Twinning in crystals – laws of twinning – types: contact, interpenetration, polysynthetic, repeated – important examples from six systems – Irregularities of crystals-An introduction to stereographic projection. | | | | | | | 12 | | | CO5 | | |
|  | **Total** | | | | | | | **60** | | |  | | |
| The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular unit. There will be equal number of Course objectives and Course outcomes.  The blooms taxonomy verbs will be given as a separate annexure for your reference.  Each course outcome should be mapped with the POs.  The mapping of each CO can be done with any number of POs.  **Course Outcomes** | | | | | | | | | | | | | |
| **Course Outcomes** | On completion of this course, students will; | | | | | | | | | | | | |
| **CO1** | Understand the origin of Galaxy, Our Solar System and Crystal Science | | | | | | | PO1 | | | | | |
| **CO2** | Knowledge on Dating of Earth Age | | | | | | | PO1, PO2 | | | | | |
| **CO3** | Correlate various Hypothesis on Origin of Earth | | | | | | | PO4, PO6 | | | | | |
| **CO4** | Analyze the importance of Crystallography Studies | | | | | | | PO4, PO5, PO6 | | | | | |
| **CO5** | Various Type minerals and their respective crystal system | | | | | | | PO3, PO8 | | | | | |
| **Text Books**  **(Latest Editions)** | | | | | | | | | | | | | |
| 1. | Mineralogy – Dexter Perkins (2014), 3rd edition, Pearson New International Edition. | | | | | | | | | | | | |
| 2. | Principles of Geomorphology; William D. Thornbury, (2004) CBS Publishers and Distributors, New Delhi. | | | | | | | | | | | | |
| 3. | Patwardhan,A.M., Dynamic Earth System, PrenticeHall, New Delhi(1999) | | | | | | | | | | | | |
| 4. | Mukherjee A.K, Principles of Geology, EW Press, KoIkata(1990) | | | | | | | | | | | | |
| 5. | Reed, J.S. &T.H. Wicander, Essentials of Geology, McGraw Hill., New York(2005 | | | | | | | | | | | | |

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| --- | --- |
| **References Books**  **(Latest editions, and the style as given below must be strictly adhered to)** | |
| 1. | Introduction to Mineralogy – William D. Nesse (2000), Oxford University press, New York. USA. |
| 2. | Textbook of Mineralogy – E.S. Dana, (2000), 3rd edition, CBS Publishers & Distributers, New Delhi. |
| 3. | Crystals and Crystal Structures – Richard J. D. Tilley(2006), John Wiley & Sons, England. |
| 4. | Introduction to Mineralogy, Crystallography & Petrology – Carl W. Correns (1967), 2nd edition, Springer |
| 5. | Radhakrishnan, V, General Geology, V.V.P. Publishers, Tuticorin (1996) |
| **Web Resources** | |
| 1. | "Age of the Earth". U.S. Geological Survey. 1997. Archived from the original on 23 December 2005*.* Retrieved 2006-01-10. |
| 2. | Dalrymple, G. Brent (2001). "The age of the Earth in the twentieth century: a problem (mostly) solved". Special Publications, Geological Society of London. |
| 3. | Geo.libretexts.org |
| 4. | www.nationalgeographic.org |
| 5. | Solarsysytem.nasa.gov |

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

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

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

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
| **CO 1** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO 2** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| **CO 5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **Subject Name** | **Category** | **L** | **T** | **P** | **S** | **Credits** | | **Inst. Hours** | **Marks** | | | |
| **CIA** | | **External** | **Total** |
| **23UGEOC14** | **Geo-Statistics - I** | Core | Y | - | - | - | 5 | | 5 | 25 | | 75 | 100 |
| **Course Objectives** | | | | | | | | | | | | | |
| CO1 | The main objective of this course is to importance of statistics in science. | | | | | | | | | | | | |
| CO2 | To describe the concepts of basic statistics | | | | | | | | | | | | |
| CO3 | To explain various components of advanced statistical methods | | | | | | | | | | | | |
| CO4 | To study various graphical methods and its applications | | | | | | | | | | | | |
| CO5 | To determine various correlation and regression studies and its importance in the field of Geology | | | | | | | | | | | | |
| **UNIT** | **Details** | | | | | | | **No. of Hours** | | | **Course Objectives** | | |
| I | Definition and scope of statistics-Tabulation of data- Formation of Frequency Distribution-Diagrammatic representation of data-Bar diagrams, Pie diagrams-Graphic Representation of data-Histogram, Frequency polygon-Ogives. | | | | | | | 12 | | | CO1 | | |
| II | Measures of Central Tendency-Arithmetic Mean Median, Mode, Combined arithmetic mean-merits and demerits. | | | | | | | 12 | | | CO2 | | |
| III | Measures of Dispersion- Absolute and Relative measures Range, Quartile deviation, Mean deviation, Standard deviation | | | | | | | 12 | | | CO3 | | |
| IV | Cure filling by the Method of Least square-Fitting straight line of the form Y=ax+b and parabola Y= a x2 + b x +c (Simple problems) | | | | | | | 12 | | | CO4 | | |
| V | Correlation-Karl person’s coefficient of correlation, Rank correlation- Spearman’s Rank correlation coefficient. Reregression-regression equation and their properties. | | | | | | | 12 | | | CO5 | | |
|  | **Total** | | | | | | | **60** | | |  | | |
| The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular unit. There will be equal number of Course objectives and Course outcomes.  The blooms taxonomy verbs will be given as a separate annexure for your reference.  Each course outcome should be mapped with the POs.  The mapping of each CO can be done with any number of POs.  **Course Outcomes** | | | | | | | | | | | | | |
| **Course Outcomes** | On completion of this course, students will; | | | | | | | | | | | | |
| **CO1** | To describe the definition, scope, classification, tabulation, drawing diagrams and plotting graphs of Statistics through Geological information. | | | | | | | PO1 | | | | | |
| **CO2** | To measure and interpret the various measures of averages using Geological data. | | | | | | | PO1, PO2 | | | | | |
| **CO3** | To measure and interpret the various measures of dispersions using Geological data. | | | | | | | PO4, PO6 | | | | | |
| **CO4** | To measure and interpret the relationship among the geological variables and to estimate and predict the unknown and future value through the regression lines using geological data. | | | | | | | PO4, PO5, PO6 | | | | | |
| **CO5** | To fit the curve using geological data. | | | | | | | PO3, PO8 | | | | | |
| **Text Books**  **(Latest Editions)** | | | | | | | | | | | | | |
| 1. | Statistics – R.S.N. Pillai and V. Bhagavathi, Publications S. Chand. | | | | | | | | | | | | |
| 2. | Statistical Methods, Gupta, S.P. (2007): Sultan Chand & Sons Pvt Ltd, New Delhi, 35th Revised Edition. | | | | | | | | | | | | |
| 3. | Statistics for Geoscientists - Marsal, D. Pergamon press, New York. | | | | | | | | | | | | |
| 4. | Cline, Graysen (2019). [Nonparametric Statistical Methods Using R](https://www.worldcat.org/oclc/1132348139). EDTECH. [ISBN](https://en.wikipedia.org/wiki/ISBN_(identifier)) [978-1-83947-325-8](https://en.wikipedia.org/wiki/Special:BookSources/978-1-83947-325-8). [OCLC](https://en.wikipedia.org/wiki/OCLC_(identifier)) [1132348139](https://www.worldcat.org/oclc/1132348139). [Archived](https://web.archive.org/web/20220515012840/https:/www.worldcat.org/title/nonparametric-statistical-methods-using-r/oclc/1132348139) from the original on 2022-05-15. Retrieved 2021-09-16. | | | | | | | | | | | | |
| 5. | Anderson, D.R.; Sweeney, D.J.; Williams, T.A. (1994) Introduction to Statistics: Concepts and Applications, pp. 5–9. West Group. [ISBN](https://en.wikipedia.org/wiki/ISBN_(identifier)) [978-0-314-03309-3](https://en.wikipedia.org/wiki/Special:BookSources/978-0-314-03309-3) | | | | | | | | | | | | |
| **References Books**  **(Latest editions, and the style as given below must be strictly adhered to)** | | | | | | | | | | | | | |
| 1. | Statistics for Geoscientists - Marsal, D. Pergamon press, New York. | | | | | | | | | | | | |
| 2. | Statistics – R.S.N. Pillai and V. Bhagavathi, Publications S. Chand. | | | | | | | | | | | | |
| 3. | Statistical Methods, Gupta, S.P. (2007): Sultan Chand & Sons Pvt Ltd, New Delhi, 35th Revised Edition. | | | | | | | | | | | | |
| 4. | Cline, Graysen (2019). [Nonparametric Statistical Methods Using R](https://www.worldcat.org/oclc/1132348139). EDTECH. [ISBN](https://en.wikipedia.org/wiki/ISBN_(identifier)) [978-1-83947-325-8](https://en.wikipedia.org/wiki/Special:BookSources/978-1-83947-325-8). [OCLC](https://en.wikipedia.org/wiki/OCLC_(identifier)) [1132348139](https://www.worldcat.org/oclc/1132348139). [Archived](https://web.archive.org/web/20220515012840/https:/www.worldcat.org/title/nonparametric-statistical-methods-using-r/oclc/1132348139) from the original on 2022-05-15. Retrieved 2021-09-16. | | | | | | | | | | | | |
| 5. | Anderson, D.R.; Sweeney, D.J.; Williams, T.A. (1994) Introduction to Statistics: Concepts and Applications, pp. 5–9. West Group. [ISBN](https://en.wikipedia.org/wiki/ISBN_(identifier)) [978-0-314-03309-3](https://en.wikipedia.org/wiki/Special:BookSources/978-0-314-03309-3) | | | | | | | | | | | | |
| **Web Resources** | | | | | | | | | | | | | |
| 1. | <https://en.wikipedia.org/wiki/Statistics> | | | | | | | | | | | | |
| 2. | <http://onlinestatbook.com/2/introduction/descriptive.html> | | | | | | | | | | | | |
| 3. | <https://socialresearchmethods.net/kb/statdesc.php> | | | | | | | | | | | | |
| 4. | <https://en.wikipedia.org/wiki/Descriptive_statistics> | | | | | | | | | | | | |
| 5. | [Philosophy of Statistics](https://plato.stanford.edu/entries/statistics/) from the [Stanford Encyclopedia of Philosophy](https://en.wikipedia.org/wiki/Stanford_Encyclopedia_of_Philosophy) | | | | | | | | | | | | |

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

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

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

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
| **CO 1** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO 2** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| **CO 5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |

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

|  |  |  |
| --- | --- | --- |
| **SEMESTER: I**  **PART: III** | **23UMATE15**  **MATHEMATICS – I** | **Credit: 3**  **Hours: 4** |

**UNIT-I: SOLUTIONS OF TRANSCENDENTAL AND ALGEBRAIC EQUATIONS**

Iteration method**,** Bisection method, Newton’s method - Regula Falsi method, (without proof) (Simple problems only)

**Unit-II: SOLUTIONS OF SIMULTANEOUS EQUATIONS**

Gauss Elimination method- Gauss Jordan method-Gauss Seidel Iterative method-Gauss Jacobi method (Restricted to three variables only) (Simple problems only)

**UNIT-III: MATRICES**

Characteristic equation of a square matrix– Eigen values and eigen vectors – Cayley – Hamilton theorem [without proof] – Verification and computation of inverse matrix.

**UNIT-IV: DIFFERENTIAL CALCULUS**

n-th derivatives – Leibnitz theorem [without proof] and applications – Jacobians– Curvature and radius of curvature in Cartesian co-ordinates

**UNIT-V: APPLICATION OF INTEGRATION**

Evaluation of double – Simple applications to area,

**TEXT BOOKS:**

1. A.Singaravelu “Numerical Methods”Meenakshi Publications

Unit-I: Chapter 2

Unit-II: Chapter 2

1. P. Duraipandian and Dr. S. Udayabaskaran. 1997, “Allied Mathematics” , Vol I & II. Chennai: Muhil Publishers.

Unit-III: Sec(4.5, 4.5.1 to 4.5.3)Vol I

Unit-IV: Sec(1.1.1, 1.1.2, 1.2, 1.4.3)vol II

Unit-V: Chap:3(3.2, 3.4, 3.4.1) vol II

**REFERENCE BOOKS:**

1. P. Balasubramanian and K. G. Subramanian. 1997, “Ancillary Mathematics”, Vol I & II. New Delhi: Tata McGraw Hill.
2. S.P.Rajagopalan and R.Sattanathan(2005), “Allied Mathematics”, Vol I & II. New Delhi: Vikas Publications.
3. P. R. Vittal (2003), “Allied Mathematics”,Chennai: Marghan Publications.

**Course Outcomes:**

On successful completion of the course, the students will be able to

**CO1**: Attain knowledge on finding Approximate root for polynomial equations using Numerical methods.

**CO2**: Develop the skills of finding solutions of Simultaneous Linear equations.

**CO3**: Adopt techniques in solving problems involving Matrices

**CO4**: Provide skills on finding curvature and radius of curvature in Cartesian and polar co-ordinates.

**CO5**:Understand the applications of double and Triple integration in real life situation.

**Outcome Mapping:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CO / PO | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 3 | 3 | 3 | 2 | 2 |
| CO2 | 3 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 2 |

**1-Low 2-Moderate 3- High**

|  |  |  |
| --- | --- | --- |
| **SEMESTER: I**  **Part: III** | **23UCHEE15**  **CHEMISTRY FOR PHYSICAL SCIENCE– I** | **Credit : 3**  **Hours : 4** |

|  |  |
| --- | --- |
| **Objectives of the course** | This course aim state provide knowledge on the   * Basics of atomic orbitals, chemical bonds, hybridization * Concepts of thermodynamics and its applications. * Concepts of nuclear chemistry * Importance of chemical industries * Qualitative and analytical methods. |
| **Course Outline** | **UNIT-I**  **Chemical Bonding and Nuclear Chemistry**  Chemical Bonding**:** Molecular Orbital Theory-bonding, anti – bonding |

|  |  |
| --- | --- |
|  | And non-bonding orbitals. Molecular orbital diagrams for Hydrogen, |
| Helium, Nitrogen; discussion of bond order and magnetic properties. |
| Nuclear Chemistry: Fundamental particles - Isotopes, Isobars, |
| Isotones and Isomers-Differences between chemical reactions and |
| Nuclear reactions-group displacement law. Nuclear binding energy- |
| Mass defect-calculations. Nuclear fission and nuclear fusion- |
| differences–Stellar energy. Applications of radioisotopes–carbon |
| dating, rock dating and medicinal applications. |
| **Unit-II** |
| **Industrial Chemistry** |
| Fuels: Fuel gases: Natural gas, water gas, semi water gas, carbureted |
| Water gas, producer gas, CNG, LPG and oil gas (manufacturing |
| Details not required). Silicones**:** Synthesis, properties and uses of |
| silicones. |
| Fertilizers: Urea, ammonium sulphate, potassium nitrate, NPK |
| fertilizer, superphosphate, triple super phosphate. |
| **UNIT-III**  **Fundamental Concepts in Organic Chemistry**  Hybridization: Orbital overlap, hybridization and geometry ofCH4, C2H4, C2H2 and C6H6. Electronic effects: Inductive effect and consequences on Ka and Kb of organic acids and bases, electromeric, mesomeric, hyper conjugation and steric-examples.  Reaction mechanisms: Types of reactions–aromaticity (Huckel’srule)  – aromatic electrophilic substitution; nitration, halogenation, Friedel-Craft’salkylationandacylation.Heterocycliccompounds:Preparation,propertiesofpyrroleandpyridine. |
| **UNIT-IV** |
| **Thermodynamics and Phase Equilibria** |
| Thermodynamics: Types of systems, reversible and irreversible |
| processes, isothermal and adiabatic processes and spontaneous |
| processes. Statements of first law and second law of thermodynamics. |
| Carnot’s cycle and efficiency of heat engine. Entropy and its |

|  |  |
| --- | --- |
|  | significance. Free energy change and its importance (noderivation). |
| Conditions for spontaneity in terms of entropy and Gibbs free energy. |
| Relation ship between Gibbs free energy and entropy. |
| Phase Equilibria**:** Phaserule – definition of termsinit. Applicationsof |
| Phase rule to water system. Two component system-Reduced phase |
| Rule and its application to asimple eutectic system (Pb-Ag). |
| **UNIT-V**  **Analytical Chemistry**  Introductiontoqualitativeandquantitativeanalysis.Principlesofvolumetricanalysis.Separationandpurificationtechniques–extraction,distillationand crystallization.  Chromatography: principle and application of column, paper and thin  Layer chromatography. |

|  |  |
| --- | --- |
| Extended | Questions related to the above topics, from various competitive |
| Professional | Examinations UPSC/JAM/TNPSC others to be solved |
| Component(isa | (To be discussed during the Tutorial hours) |
| Part of internal |  |
| Component only, |  |
| Not to be included |  |
| In the external |  |
| examination |  |
| Question paper) |  |
| Skills acquired  From this course | Knowledge, Problem solving, Analytical ability, Professional  Competency, Professional Communication and Transferable skills. |
| **Recommended Text** | 1. V.Veeraiyan, Textbook of Ancillary Chemistry; High mount publishing house,Chennai,firstedition,2009. 2. S.Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur,2006. 3. S.ArunBahl,B.S.Bahl, Advanced Organic Chemistry; S.Chandand Company, NewDelhi, twentythirdedition,2012. 4. P.L.Soni,H.M.Chawla, Text Book of Organic Chemistry; Sultan   Chand&sons,NewDelhi, twentyninth edition,2007. |
| **Reference Books** | 1. P.L.Soni,Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, NewDelhi, twentieth edition,2007. 2. B.R.Puri,L.R.Sharma, M.S.Pathania, Text book Physical Chemistry; Vishal Publishing Co.,NewDelhi, forty seventh edition,2018. 3. B.K,Sharma, Industrial Chemistry; GOEL publishing house, Meerut,   sixteenth edition,2014. |
| **Website and e-learning source** | 1. <https://byjus.com/jee/chemical-bonding/> 2. <https://en.wikipedia.org/wiki/Fuel> 3. <https://www.brainkart.com/article/Fundamentals-of-Organic-Chemistry_36450/> 4. <https://chem.libretexts.org/Courses/BethuneCookman_University/B-CU%3A_CH-345_Quantitative_Analysis/Book%3A_Analytical_Chemistry_2.1_(Harvey)/06%3A_Equilibrium_Chemistry/6.02%3A_Thermodynamics_and_Equilibrium_Chemistry> 5. https://en.wikipedia.org/wiki/Chromatography |

|  |
| --- |
| **Course Learning Outcomes (for Mapping with Pos and PSOs)**  **On completion of the course the students should be able to** |
| CO1: Gain in-depth knowledge about the theories of chemical bonding, nuclear reactions and its applications.  CO2: Evaluate the efficiencies and uses of various fuels and fertilizers  CO3: Explain the type of hybridization, electronic effect and mechanism involved in the organic reactions.  CO4: Apply various thermodynamic principles, systems and phase rule.  CO5:Explain various methods to identify anappropriate method for the separation of chemical components |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |
| **Weightage** | 15 | 15 | 15 | 15 | 15 |
| **Weighted percentage of**  **Course Contribution to POs** | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Weightage** | 15 | 15 | 15 | 15 | 15 |
| **Weighted percentage of**  **Course Contribution to POs** | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |

**Level of Correlation between PO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **Subject Name** | **Category** | **L** | **T** | **P** | **S** | **Credits** | | **Inst. Hours** | **Marks** | | | |
| **CIA** | | **External** | **Total** |
| **23UGEON16** | **Understanding the Earth** | NME | Y | - | - | - | 2 | | 2 | 25 | | 75 | 100 |
| **Course Objectives** | | | | | | | | | | | | | |
| CO1 | The main objective of this course is to understand various properties of Earth. | | | | | | | | | | | | |
| CO2 | To describe the concepts of internal structure of the Earth | | | | | | | | | | | | |
| CO3 | To explain various components related to external processes of Earth | | | | | | | | | | | | |
| CO4 | To study concepts of various currents and atmospheric circulation. | | | | | | | | | | | | |
| CO5 | To understand the availability of elements in the Earth. | | | | | | | | | | | | |
| **UNIT** | **Details** | | | | | | | **No. of Hours** | | | **Course Objectives** | | |
| I | Understanding of planet Earth: Astronomy, Geology, Meteorology and Oceanography. General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and jovian planets. Meteorites and Asteroids Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters and its age. | | | | | | | 12 | | | CO1 | | |
| II | Internal structure: core, mantle, crust; External Structure: hydrosphere, atmosphere and biosphere. Earth's magnetic field. | | | | | | | 12 | | | CO2 | | |
| III | Plate tectonics, sea-floor spreading and continental drift; Mid Oceanic Ridges, trenches, transform faults and island arcs Origin of oceans, continents, mountains and rift valleys Earthquake and Volcanoes. | | | | | | | 12 | | | CO3 | | |
| IV | Concepts of eustasy; Land-air-sea interaction Oceanic current system and effect of Coriolis force; Wave erosion and beach processes Atmospheric circulation; Weather and climatic changes. | | | | | | | 12 | | | CO4 | | |
| V | Distribution of elements in solar system and in Earth; Chemical differentiation and composition of the Earth; General concepts about geochemical cycles and mass balance  Properties of elements; Geochemical behavior of major elements; Mass conservation of elements and isotopic fractionation. | | | | | | | 12 | | | CO5 | | |
|  | **Total** | | | | | | | **60** | | |  | | |
| **The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular unit. There will be equal number of Course objectives and Course outcomes.**  **The blooms taxonomy verbs will be given as a separate annexure for your reference.**  **Each course outcome should be mapped with the POs.**  **The mapping of each CO can be done with any number of POs.**  **Course Outcomes** | | | | | | | | | | | | | |
| **Course Outcomes** | On completion of this course, students will; | | | | | | | | | | | | |
| **CO1** | Understand the properties of Earth | | | | | | | PO1 | | | | | |
| **CO2** | Knowledge on Dating of Earth Age | | | | | | | PO1, PO2 | | | | | |
| **CO3** | Correlate various Hypothesis on Origin of Earth | | | | | | | PO4, PO6 | | | | | |
| **CO4** | Analyze the importance of Crystallography Studies | | | | | | | PO4, PO5, PO6 | | | | | |
| **CO5** | Various Type minerals and their respective crystal system | | | | | | | PO3, PO8 | | | | | |
| **Text Books**  **(Latest Editions)** | | | | | | | | | | | | | |
| 1. | Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis. | | | | | | | | | | | | |
| 2. | Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press. | | | | | | | | | | | | |
| 3. | Patwardhan,A.M., Dynamic Earth System, PrenticeHall, New Delhi(1999) | | | | | | | | | | | | |
| 4. | Mukherjee A.K, Principles of Geology, EW Press, KoIkata(1990) | | | | | | | | | | | | |
| 5. | Reed, J.S. &T.H. Wicander, Essentials of Geology, McGraw Hill., New York(2005 | | | | | | | | | | | | |
| **References Books**  **(Latest editions, and the style as given below must be strictly adhered to)** | | | | | | | | | | | | | |
| 1. | Gross, M. G. (1977). Oceanography: A view of the earth. | | | | | | | | | | | | |
| 2. | Principles of Geomorphology; William D. Thornbury, (2004) CBS Publishers and Distributors, New Delhi. | | | | | | | | | | | | |
| 3. | Crystals and Crystal Structures – Richard J. D. Tilley(2006), John Wiley & Sons, England. | | | | | | | | | | | | |
| 4. | Introduction to Mineralogy, Crystallography & Petrology – Carl W. Correns (1967), 2nd edition, Springer | | | | | | | | | | | | |
| 5. | Radhakrishnan, V, General Geology, V.V.P. Publishers, Tuticorin (1996) | | | | | | | | | | | | |
| **Web Resources** | | | | | | | | | | | | | |
| 1. | "Age of the Earth". U.S. Geological Survey. 1997. Archived from the original on 23 December 2005*.* Retrieved 2006-01-10. | | | | | | | | | | | | |
| 2. | Dalrymple, G. Brent (2001). "The age of the Earth in the twentieth century: a problem (mostly) solved". Special Publications, Geological Society of London. | | | | | | | | | | | | |
| 3. | Geo.libretexts.org | | | | | | | | | | | | |
| 4. | www.nationalgeographic.org | | | | | | | | | | | | |
| 5. | Solarsysytem.nasa.gov | | | | | | | | | | | | |

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

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

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

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
| **CO 1** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO 2** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| **CO 5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **Subject Name** | **Category** | **L** | **T** | **P** | **S** | **Credits** | | **Inst. Hours** | **Marks** | | | |
| **CIA** | | **External** | **Total** |
| **23UGEOF17** | **Rudiments of Geohazards** | FC | Y | - | - | - | 2 | | 2 | 25 | | 75 | 100 |
| **Course Objectives** | | | | | | | | | | | | | |
| CO1 | To explain students about the physical and geological processes causing geohazards. | | | | | | | | | | | | |
| CO2 | To discuss the methods for quantifying geohazards | | | | | | | | | | | | |
| CO3 | To understand the possible consequences as well as risk and disaster management. | | | | | | | | | | | | |
| CO4 | To make them aware about landslides, floods, tsunamis and earthquakes, for which the geological and physical process were to be discussed. | | | | | | | | | | | | |
| CO5 | To discuss potential inter linkages between different types of geohazards, disaster prevention and management and quantification and communication of uncertainties. | | | | | | | | | | | | |
| **UNIT** | **Details** | | | | | | **No. of Hours** | | | | **Course Objectives** | | |
| I | **Geological Hazards:** Introduction to natural hazards. Earthquakes: Causes and measurements – Earthquake and Tsunami Hazards. | | | | | | 2 Hours / week | | | | CO1 | | |
| II | **Volcanoes:** Magma and lava - volcanic eruptions - volcanic landforms - volcanic hazards. | | | | | | 2 Hours / week | | | | CO2 | | |
| III | **Landslides:** Mass wasting and Mass wasting processes – Slope stability, triggering events, mass wasting hazards – subsidence. | | | | | | 2 Hours / week | | | | CO3 | | |
| IV | **Storms:** The Ocean - Atmosphere System – Thunderstorms & Tornadoes – Tropical Cyclones – Hurricane – Windstorms – Lightening – Drought – wildfire. | | | | | | 2 Hours / week | | | | CO4 | | |
| V | **River systems:** Causes of flooding – river flooding – flooding hazards. Extra-terrestrial hazards. Meteorites &impacting events. | | | | | | 2 Hours / week | | | | CO5 | | |
|  | **Total** | | | | | |  | | | |  | | |
| **The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular unit. There will be equal number of Course objectives and Course outcomes.**  **The blooms taxonomy verbs will be given as a separate annexure for your reference.**  **Each course outcome should be mapped with the POs.**  **The mapping of each CO can be done with any number of POs.**  **Course Outcomes** | | | | | | | | | | | | | |
| **Course Outcomes** | On completion of this course, students will; | | | | | | | | | | | | |
| **CO1** | Understand different natural hazards. | | | | | | | PO1 | | | | | |
| **CO2** | Knowledge on volcanic hazards. | | | | | | | PO1, PO2 | | | | | |
| **CO3** | Understand mass wasting and subsidence processes | | | | | | | PO4, PO6 | | | | | |
| **CO4** | Analyze the importance of storm studies | | | | | | | PO4, PO5, PO6 | | | | | |
| **CO5** | Various types of river hazards | | | | | | | PO3, PO8 | | | | | |
| **Text Books**  **(Latest Editions)** | | | | | | | | | | | | | |
| 1. | Montgomery, C.W. (2008), Environmental Geology, McGraw Hill 8thEdition. | | | | | | | | | | | | |
| 2. | Abbott Patrick, L. (2006), Natural Disasters, McGraw Hill, Boston, MA. | | | | | | | | | | | | |
| 3. | Bryant, E. (2005), Natural Hazards, Cambridge University Press, Cambridge, U.K. | | | | | | | | | | | | |

**SEMESTER II**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **Subject Name** | **Category** | **L** | **T** | **P** | **S** | **Credits** | | **Inst. Hours** | **Marks** | | | |
| **CIA** | | **External** | **Total** |
| **23UGEOC23** | **PALAEONTOLOGY** | Core | Y | - | - | - | 5 | | 5 | 25 | | 75 | 100 |
| **Course Objectives** | | | | | | | | | | | | | |
| CO1 | Understand the basics of Fossils | | | | | | | | | | | | |
| CO2 | Understand the importance of fossils in Geological studies | | | | | | | | | | | | |
| CO3 | Know different phulum and their species with morphological changes | | | | | | | | | | | | |
| CO4 | Understand and correlate fossil with various rock formations | | | | | | | | | | | | |
| CO5 | Understand the importance of Palaeontology in dating and evolution studies | | | | | | | | | | | | |
| **UNIT** | **Details** | | | | | | | **No. of Hours** | | | **Course Objectives** | | |
| I | Fossils –Definition-conditions required for fossilization-Modes of preservation-Uses of fossils. Geological time scale. | | | | | | | 12 | | | CO1 | | |
| II | The morphology and geological distribution of Mollusca- classes, Pelecypoda, gastropoda, Cephalopoda – orders - Nautiloidea, Ammonoidea, Dibranchia – Belemnites. | | | | | | | 12 | | | CO2 | | |
| III | Phylum – Brachiopoda, Phylum – Coelenterata.Class Anthozoa – Subclass Zoantharia Orders Rugosa, Tabulata and Scaleractina. Phylum – Hemichordata – Class Graptozoa, order Dendroidea, Order Graptolitoidea. | | | | | | | 12 | | | CO3 | | |
| IV | Phylum – Arthropoda Class – Trilobita Phylum – Echinodermata Class - Echinoidea Class – Crinoidea. Class: Blastoidea. Introduction to Paleobotany, Gondwana Flora. | | | | | | | 12 | | | CO4 | | |
| V | Short account of the following Dinosaurs, Saurischian Dinosaur and Ornithistian Dinosaurs, Archaeopteryx, Elementary idea of Verterbrate fossils of India, Morphological character of Phylum – Protozoa, Order – Foraminifera. | | | | | | | 12 | | | CO5 | | |
|  | **Total** | | | | | | | **60** | | |  | | |
| **The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular unit. There will be equal number of Course objectives and Course outcomes.**  **The blooms taxonomy verbs will be given as a separate annexure for your reference.**  **Each course outcome should be mapped with the POs.**  **The mapping of each CO can be done with any number of POs.**  **Course Outcomes** | | | | | | | | | | | | | |
| **Course Outcomes** | On completion of this course, students will; | | | | | | | | | | | | |
| **CO1** | Understand the basics of Fossils | | | | | | | PO1 | | | | | |
| **CO2** | Understand the importance of fossils in Geological studies | | | | | | | PO1, PO2 | | | | | |
| **CO3** | Know different phulum and their species with morphological changes | | | | | | | PO4, PO6 | | | | | |
| **CO4** | Understand and correlate fossil with various rock formations | | | | | | | PO4, PO5, PO6 | | | | | |
| **CO5** | Understand the importance of Palaeontology in dating and evolution studies | | | | | | | PO3, PO8 | | | | | |
| **Text Books**  **(Latest Editions)** | | | | | | | | | | | | | |
| 1. | Palaeontology Evolution and animal distribution. .C. Jain and M.S. Anantharaman, (1996), Vishal Publications, Jalandhar. | | | | | | | | | | | | |
| 2. | Invertebrate Palaeontology - H.Woods, (1985), CBS Publishers and Distributors, New Delhi. | | | | | | | | | | | | |
| 3. | Agashe, S.N, Paleo botany, Oxford & IBH. Delhi(1995) | | | | | | | | | | | | |
| 4. | Stewart W.N. & G.W. Rothwell, Palaeobotany, Cambridge University Press. D 2005) | | | | | | | | | | | | |
| 5. | Moore R.C. et al., Invertebrate Fossils. CBS. Delhi (1952). | | | | | | | | | | | | |
| **References Books**  **(Latest editions, and the style as given below must be strictly adhered to)** | | | | | | | | | | | | | |
| 1. | Principles of Invertebrate Palaeontology, Shrock R.R and Twenohofel W.H, (2005), CBS Publishers and Distributors, New Delhi. | | | | | | | | | | | | |
| 2. | Invertebrate Fossils. Moore R.C, Lalicker C.G and Fisher A.G (1952) McGraw Hill. | | | | | | | | | | | | |
| 3. | The Vertebrate Story, Romer A.S, (1959) University of Chicago Press, 4thEdt. Chicago. | | | | | | | | | | | | |
| 4. | Palaeontology An Introduction, E.W.Nield and V.C.T.Tucker (1985) Pergamon Press, Oxford. | | | | | | | | | | | | |
| 5. | Colbert E.H. et al.,Evolution of the Vertebrates, Wiley. New Delhi 2002) | | | | | | | | | | | | |
| **Web Resources** | | | | | | | | | | | | | |
| 1. | "Age of the Earth". U.S. Geological Survey. 1997. Archived from the original on 23 December 2005*.* Retrieved 2006-01-10. | | | | | | | | | | | | |
| 2. | Dalrymple, G. Brent (2001). "The age of the Earth in the twentieth century: a problem (mostly) solved". Special Publications, Geological Society of London. | | | | | | | | | | | | |
| 3. | Digitalatlas.cose.ISU.edu>geo>basics>fossil | | | | | | | | | | | | |
| 4. | www.sciencedirect.com>topic>hemichordata | | | | | | | | | | | | |
| 5. | w.qm.qid.au>biodiscovery>corals | | | | | | | | | | | | |

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

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

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

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
| **CO 1** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO 2** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| **CO 5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **Subject Name** | **Category** | **L** | **T** | **P** | **S** | **Credits** | | **Inst. Hours** | **Marks** | | | |
| **CIA** | | **External** | **Total** |
| **23UGEOP24** | CRYSTALLOGRAPHY AND PALAEONTOLOGY PRACTICAL | Core | Y | - | - | - | 5 | | 5 | 25 | | 75 | 100 |
| **Course Objectives** | | | | | | | | | | | | | |
| CO1 | The main objective of this course is to enumerate the origin of Earth. | | | | | | | | | | | | |
| CO2 | To describe the concepts of Dating and internal structure of the Earth | | | | | | | | | | | | |
| CO3 | To explain various components of crystals and crystallography | | | | | | | | | | | | |
| CO4 | To study various class and forms of an crystal system. | | | | | | | | | | | | |
| CO5 | To determine various crystallographic properties of crystals with suitable examples. | | | | | | | | | | | | |
| **UNIT** | **Details** | | | | | | | **No. of Hours** | | | **Course Objectives** | | |
| I | Isometric System: Normal Class – Galena, Fluorite, Magnetite, Garnet, and Leucite, Copper- Pyritohedral class – Pyrite, Tetrahedral Class – Tetrahedrite.  Tetragonal System: Normal Class – Zircon, Vesuvianite, Cassiterite, and Rutile. Tripyramidal – Scheelite, MeioniteSphenidal Class – Chalcopyrite.  Hexagonal System: Normal Class – Beryl, Tripyramidal – Apatite, Hemimorphic – Zincite, Rhombohedral Normal – Calcite, Trapezohedral Class – Quartz. | | | | | | | 12 | | | CO1 | | |
| II | Orthorhombic System: Normal – Barite, Sulphur, Stibnite, Topaz, Staurolite, and Aragonite. Hemimorphic – Calymene, Sphenoidal Class – Epsomite.  Monoclinic System: Normal – Gypsum, Pyroxenes and Amphiboles.  Triclinic System: Normal – Axinite, Albite, and Rhodonite.  Twin Crystals: Contact and Penetration twins of Fluorite, Iron Cross Twin of Pyrite, Knee type twin of Cassiterite, Polysynthetic twin of Aragonite, Cyclic twin of Cerussite, Swallow Tail of Gypsum, Twins of Carlsbad, Baveno, Manebach, Albite law of Albite. | | | | | | | 12 | | | CO2 | | |
| III | Identification and description of the following fossils: Lamellibranchs: Arca, Meretrix, Pecten, Cardita, Lima, Allectronia, Inoceramus, Gryphaea, Exogyra, Radiolites, Ostrea, Unio, Trigonia. Gastropods: Turritella, Turbo, Cerithium, Trochus, Physa, Murex, Voluta, Helix, Euomphalus, Cyprea. | | | | | | | 12 | | | CO3 | | |
| IV | Cephalopods: Nautilus, Orthoceras, Ceratite, Goniatite, Belemnites, Baculites, and Perisphinctes. Echinodermata: Cidaris, Holaster, Hemiaster, Stigmatophygus, Apiocrinus. Trilobites: Paradoxides, Olenus, Olenellus, Phacops, Calymene. | | | | | | | 12 | | | CO4 | | |
| V | Corals: Calceola, Zaphrentis, Lithostrotion, Omphyma, Thecosmelia. Brachiopoda: Terebratula, Spirifer, Productus, Monograptus, Tetragraptus, Diplograptus. | | | | | | | 12 | | | CO5 | | |
|  | **Total** | | | | | | | **60** | | |  | | |
| **The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular unit. There will be equal number of Course objectives and Course outcomes.**  **The blooms taxonomy verbs will be given as a separate annexure for your reference.**  **Each course outcome should be mapped with the POs.**  **The mapping of each CO can be done with any number of POs.**  **Course Outcomes** | | | | | | | | | | | | | |
| **Course Outcomes** | On completion of this course, students will; | | | | | | | | | | | | |
| **CO1** | The main objective of this course is to enumerate the fundamental aspects of Mineralogy in such a way as to stimulate the minds of the post-graduate students. | | | | | | | PO1 | | | | | |
| **CO2** | To describe the concepts of Mineralogy is essential to comprehend the concepts of Petrology. | | | | | | | PO1, PO2 | | | | | |
| **CO3** | To explain the importance of instrumentation techniques for better analysis | | | | | | | PO4, PO6 | | | | | |
| **CO4** | To compare and contrast between the fascinating plethora of colorful minerals and crystals, this discipline requires good knowledge of Chemistry, and poses several intriguing questions, leading to sustained interest in this subject | | | | | | | PO4, PO5, PO6 | | | | | |
| **CO5** | Can evaluate the accuracy and summaries the methods adapted for certain practical activities. | | | | | | | PO3, PO8 | | | | | |
| **Text Books**  **(Latest Editions)** | | | | | | | | | | | | | |
| 1. | Mineralogy – Dexter Perkins (2014), 3rd edition, Pearson New International Edition. | | | | | | | | | | | | |
| 2. | Principles of Geomorphology; William D. Thornbury, (2004) CBS Publishers and Distributors, New Delhi. | | | | | | | | | | | | |
| 3. | Agashe, S.N, Paleo botany, Oxford & IBH. Delhi(1995) | | | | | | | | | | | | |
| 4. | Stewart W.N. & G.W. Rothwell, Palaeobotany, Cambridge University Press. D 2005) | | | | | | | | | | | | |
| 5. | Moore R.C. et al., Invertebrate Fossils. CBS. Delhi (1952). | | | | | | | | | | | | |
| **References Books**  **(Latest editions, and the style as given below must be strictly adhered to)** | | | | | | | | | | | | | |
| 1. | Introduction to Mineralogy – William D. Nesse (2000), Oxford University press, New York. USA. | | | | | | | | | | | | |
| 2. | Textbook of Mineralogy – E.S. Dana, (2000), 3rd edition, CBS Publishers & Distributers, New Delhi. | | | | | | | | | | | | |
| 3. | Crystals and Crystal Structures – Richard J. D. Tilley(2006), John Wiley & Sons, England. | | | | | | | | | | | | |
| 4. | Introduction to Mineralogy, Crystallography & Petrology – Carl W. Correns (1967), 2nd edition, Springer | | | | | | | | | | | | |
| 5. | Colbert E.H. et al.,Evolution of the Vertebrates, Wiley. New Delhi 2002) | | | | | | | | | | | | |
| **Web Resources** | | | | | | | | | | | | | |
| 1. | "Age of the Earth". U.S. Geological Survey. 1997. Archived from the original on 23 December 2005*.* Retrieved 2006-01-10. | | | | | | | | | | | | |
| 2. | Dalrymple, G. Brent (2001). "The age of the Earth in the twentieth century: a problem (mostly) solved". Special Publications, Geological Society of London. | | | | | | | | | | | | |
| 3. | Digitalatlas.cose.ISU.edu>geo>basics>fossil | | | | | | | | | | | | |
| 4. | www.sciencedirect.com>topic>hemichordata | | | | | | | | | | | | |
| 5. | w.qm.qid.au>biodiscovery>corals | | | | | | | | | | | | |

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

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

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

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
| **CO 1** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO 2** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| **CO 5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |

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

|  |  |  |
| --- | --- | --- |
| **SEMESTER: II**  **PART: II**  **Core IV** | **23UMATE25**  **MATHEMATICS – II** | **Credit: 3**  **Hours: 5** |

**UNIT-I:TRIGONOMETRY**

Expansions of sin n θ, cos n θ, sinnθ,cosnθ, tannθ – Expansions of sinθ, cosθ, tanθ in terms of θ

Unit-I: Chap: 6 (6.1,6.1.1 to 6.1.3)

**UNIT-II: PARTIAL DIFFERENTIAL EQUATIONS**

Formation of partial differential equations, elimentary partial differential equations- Lagranges equations.

Unit-II: Chap:6 (6.1,6.1.1, 6.4).

**UNIT-III: VECTOR DIFFRENTIATION**

Vector functions- Scalar and vector point functions- Directional derivatives –Unit vector normal to a surface – angle between the surfaces-divergence, Gradient of a scalar point function- Divergence and curl of a vector point function.

Unit-III Section 8.1,8.2,8.3, 8.4).

**UNIT-IV: VECTOR INTEGRATION**

Green’s theorem in the plane-Gauss divergence theorem- [without proofs] ,Stoke’s theorem

( Statement only)

Unit-IV:Section(8.6.1, to 8.6.3).

**UNIT-V: FINITE DIFFERENCES**

Operator E, Relation between  and E – Interpolation – Newton – Gregory forward & backward formulae for interpolation-Lagrange’s interpolation formula for unequal intervals(without proof) .

Unit-V:Sec(5.1,5.2).

**TEXT BOOK:**

1.P. Duraipandian and S. Udayabaskaran(1997), “Allied Mathematics”, Vol I & II. Chennai:

Muhil Publishers.

Unit-I: Chap: 6 (6.1,6.1,1 to 6.1.3), Vol I,

Unit-II: Chap:6 (6.1,6.1.1,6.4), Vol II,

Unit-IIISec(8.1,8.2,8.3,8.4),Vol I,

Unit-IV:Sec(8.6.1, - 8.6.3), Vol I,

Unit-V:Sec(5.1,5.2), Vol II.

**REFERENCE BOOKS:**

1. P. Balasubramanian and K. G. Subramanian. 1997, “Ancillary Mathematics”, Vol I & II. New Delhi: Tata McGraw Hill.
2. S.P.Rajagopalan and R.Sattanathan(2005), “Allied Mathematics”, Vol I & II. New Delhi: Vikas Publications.
3. P. R. Vittal (2003), “Allied Mathematics”,Chennai: Marghan Publications.
4. P.Kandhasamy, K. Thilagavathy (2003), “Allied Mathematics” Vol I & II, New Delhi: Tata McGraw Hill.

**Course Outcomes:**

On successful completion of the course, the students will be able to

**CO1**: Attain knowledge on finding the expansions of trigonometric functions and concept of hyperbolic and inverse hyperbolic functions.

**CO2**: Provide a basic knowledge of Partial Differential equations and develops knowledge on handle practical problems.

**CO3**: Adopt techniques in solving problems involving vector and scalar functions

**CO4**: Provide skills on finding derivatives and gradients on vector differentiation and

Integration.

**CO5**: Understand the applications of differentiation and integration in real life situation.

**Outcome Mapping:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CO / PO | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 3 | 3 | 3 | 2 | 2 |
| CO2 | 3 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 2 |

**1-Low 2-Moderate 3- High**

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| --- | --- | --- |
| **SEMESTER: II**  **Part: III** | **23UCHEE25**  **Chemistry for Physical Science– II** | **Credit: 2**  **Hours: 3** |

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| **Objectives of the course** | This course aims at providing knowledge on the   * Co-ordination Chemistry and Water Technology * Carbohydrates and Amino acids * basics and applications of electrochemistry * basics and applications of kinetics and catalysis * Various photochemical phenomenon |
| **Course Outline** | **UNIT I**  **Co-ordination Chemistry and Water Technology**  Co-ordination Chemistry: Definition of terms-IUPAC Nomenclature - Werner’stheory - EAN rule - Pauling’s theory – Postulates - Applications to [Ni(CO)4], [Ni(CN)4]2-,[Co(CN)6]3- Chelation - Biological role of Haemoglobin and Chlorophyll (elementary idea) – Applications in qualitative and quantitative analysis.  Water Technology: Hardness of water, determination of hardness of water using EDTA method, zeolite method-Purification techniques-  BOD, COD. |
| **Unit II**  **Carbohydrates and Amino acids**  Carbohydrates: Classification, preparation and properties of glucose, fructose and sucrose. Discussion of open chain ring structures of glucose and fructose. Glucose –fructose interconversion. Properties of starch and cellulose.  Amino acids: Classification - preparation and properties of  alanine, preparation of dipeptides using Bergmann method. RNA and DNA (elementary idea only). |
| **UNIT III**  **Electrochemistry**  Galvanic cells - Standard hydrogen electrode - calomel electrode - standard electrode potentials -electrochemical series. Strong and weak electrolytes - ionic product of water -pH, pKa, pKb. Conductometric titrations - pH determination by colorimetric method – buffer solutions and its biological applications - electroplating - Nickel and chrome plating – Types of cells -fuel cells-corrosion and its prevention. |
|  | **UNIT IV**  **Kinetics and Catalysis**  Order and molecularity. Integrated rate expression for I and II (2A  Products) order reactions. Pseudo first order reaction, methods of determining order of a reaction – Half-life period – Catalysis - homogeneous and heterogeneous, catalyst used in Contact and Haber’s processes. Concept of energy of activation and Arrhenius  equation. |
|  | **UNIT V**  **Photochemistry**  Grothus-Draper’s law and Stark-Einstein’s law of photochemical equivalence, Quantum yield - Hydrogen-chloride reaction. Phosphorescence, fluorescence, chemiluminescence and  photosensitization and photosynthesis (definition with examples). |
| Extended Professional Component (is a part of internal component only, Not to be included in the external examination  question paper) | Questions related to the above topics, from various competitive examinations UPSC/ JAM /TNPSC others to be solved  (To be discussed during the Tutorial hours) |

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| Skills acquired  from this course | Knowledge, Problem solving, Analytical ability, Professional  Competency, Professional Communication and Transferable skills. |
| **Recommended Text** | 1. V.Veeraiyan, Textbook of Ancillary Chemistry; High mount publishing house, Chennai, first edition,2009. 2. S.Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur,2006. 3. Arun Bahl, B.S.Bahl, Advanced Organic Chemistry; S.Chand and Company, New Delhi, twenty third edition, 2012. 4. P.L.Soni, H.M.Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007. |
| **Reference Books** | 1. P.L.Soni, Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, New Delhi, twentieth edition, 2007. 2. R.Puri, L.R.Sharma, M.S.Pathania, Text book Physical Chemistry;   Vishal Publishing Co., New Delhi, forty seventh edition, 2018.  3. B.K,Sharma, Industrial Chemistry; Meerut, sixteenth edition, 2014.  GOEL publishing house, |
| **Website and**  **e-learning source** |  |
| **Course Learning Outcomes (for Mapping with POs and PSOs) On completion of the course the students should be able to**  **CO 1:** write the IUPAC name for complex, different theories to explain the bonding in coordination compounds and water technology  **CO 2:** explain the preparation and property of carbohydrate, amino acids and nucleic acids.  **CO 3:** apply/demonstrate the electrochemistry principles in corrosion, electroplating and fuel cells.  **CO 4:** identify the reaction rate, order for chemical reaction and explain the purpose of a catalyst.  **CO 5:** outline the various type of photochemical process. | |

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| **CO /PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |
| **Weightage** | 15 | 15 | 15 | 15 | 15 |
| **Weighted percentage of Course Contribution to**  **PSOs** | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |

**Level of Correlation between PSO’s and CO’s**

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| --- | --- | --- |
| **SEMESTER: I**  **Part: III** | **23UCHEEP1**  **CHEMISTRY PRACTICAL FOR PHYSICAL SCIENCE – I** | **Credit : 1**  **Hours : 2** |

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| **Objectives of the course** | This course aims to provide knowledge on the   * basics of preparation of solutions. * principles and practical experience of volumetric analysis |
| **Course Outline** | **VOLUMETRIC ANALYSIS**   1. Estimation of sodium hydroxide using standard sodium carbonate. 2. Estimation of hydrochloric acid using standard oxalic acid. 3. Estimation of ferrous sulphate using standard Mohr's salt. 4. Estimation of oxalic acid using standard ferrous sulphate. 5. Estimation of potassium permanganate using standard sodium hydroxide. 6. Estimation of magnesium using EDTA. 7. Estimation of ferrous ion using diphenyl amine as indicator. |
| **Reference Books** | V.Venkateswaran, R.Veerasamy, A.R.Kulandaivelu, Basic Principles ofPractical Chemistry; Sultan Chand & sons, Second edition, 1997. |
| **Website and E-Learning Sources** | 1)http://www.federica.unina.it/agraria/analytical-chemistry/volumetricanalysis  2)https://chemdictionary.org/titration-indicator/ |
| **Course Learning Outcomes (for Mapping with POs and PSOs) On completion of the course the students should be able to**  CO 1: gain an understanding of the use of standard flask and volumetric pipettes, burette. CO 2: design, carry out, record and interpret the results of volumetric titration.  CO 3: apply their skill in the analysis of water/hardness.  CO4: analyze the chemical constituents in allied chemical products | |

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| **CO /PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **Weightage** | 12 | 12 | 12 | 12 | 12 |
| **Weighted percentage of**  **Course Contribution to PSOs** | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |

**Level of Correlation between PSO’s and CO’s**

**Note: Scheme for Practical Evaluation.**

**Volumetric Estimation – 75**

**Record – 10 marks**

**Procedure – 15marks**

**Results**

**< 2% - 50 marks**

**2-3% - 40 marks**

**3-4% - 30 marks**

**> 4% - 20 marks**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **Subject Name** | **Category** | **L** | **T** | **P** | **S** | **Credits** | | **Inst. Hours** | **Marks** | | | |
| **CIA** | | **External** | **Total** |
| **23UGEON26** | **Basics of Earth Science** | NME | Y | - | - | - | 2 | | 2 | 25 | | 75 | 100 |
| **Course Objectives** | | | | | | | | | | | | | |
| CO1 | The main objective of this course is to understand various properties of Earth. | | | | | | | | | | | | |
| CO2 | To describe the concepts of internal structure of the Earth | | | | | | | | | | | | |
| CO3 | To explain various components related to external processes of Earth | | | | | | | | | | | | |
| CO4 | To study concepts of various currents and atmospheric circulation. | | | | | | | | | | | | |
| CO5 | To understand the availability of elements in the Earth. | | | | | | | | | | | | |
| **UNIT** | **Details** | | | | | | | **No. of Hours** | | | **Course Objectives** | | |
| I | Universe – Evolution of the Universe. Solar System – Inner and outer planets – characteristics of solar system. Satellites – Asteroids – Meteors – comets. Earth – movements – revolution – rotation – solstice – equinox. Atmosphere - El Nino – hydrosphere – lithosphere- Origin of the Earth. | | | | | | | 2 hours / week | | | CO1 | | |
| II | Age of the Earth - old methods – new methods – Radioactivity – Half-life period – Radiometric methods. Interior of the Earth – Density – Shape – Seismic waves – Composition and thickness of the crust, mantle and core. Discontinuities: Conrad Discontinuity – Mohorovicic Discontinuity. | | | | | | | 2 hours / week | | | CO2 | | |
| III | Introduction to Geomorphology: Geological action of wind, water, glaciers and ground water. Volcanoes and earthquakes. Rock deformation: Folds, Faults, Joints, Cleavage, Unconformities, Concepts of plate tectonics, sea floor spreading and geosynclines. | | | | | | | 2 hours / week | | | CO3 | | |
| IV | **Study of Fossils-** Introduction, Geological Record and its nature. Geological Time Scale. Introduction, Definition of Paleontology, Classification of Plants, Invertebrate and Vertebrate fossils. Fossils -Tophonomy (Burial Law), Types of Fossilization, Mode of preservation- Applications of Fossils – National fossil parks across India. | | | | | | | 2 hours / week | | | CO4 | | |

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| V | **Applications of Geology:**Environmental impacts due to mining and mineral process, Engineering Geology: Dams, Reservoirs and Tunnels, strategic, critical and essential mineral –Mineral resources of India. Fossil Fuels and Groundwater. | 2 hours / week | CO5 |
|  | **Total** | **60** |  |
| **The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular unit. There will be equal number of Course objectives and Course outcomes.**  **The blooms taxonomy verbs will be given as a separate annexure for your reference.**  **Each course outcome should be mapped with the POs.**  **The mapping of each CO can be done with any number of POs.**  **Course Outcomes** | | | |
| **Course Outcomes** | On completion of this course, students will; | | |
| **CO1** | Gather basic information on Earth Sciences | PO1 | |
| **CO2** | Understand the importance of various components of Earth | PO1, PO2 | |
| **CO3** | Process of Geomorphological features | PO4, PO6 | |
| **CO4** | Understand, predict and analyze the fossil and dating | PO4, PO5, PO6 | |
| **CO5** | Apply the geological knowledge in various civil structures | PO3, PO8 | |
| **Text Books**  **(Latest Editions)** | | | |
| 1. | Mineralogy – Dexter Perkins (2014), 3rd edition, Pearson New International Edition. | | |
| 2. | Principles of Geomorphology; William D. Thornbury, (2004) CBS Publishers and Distributors, New Delhi. | | |
| 3. | Patwardhan,A.M., Dynamic Earth System, PrenticeHall, New Delhi(1999) | | |
| 4. | Mukherjee A.K, Principles of Geology, EW Press, KoIkata(1990) | | |
| 5. | Reed, J.S. &T.H. Wicander, Essentials of Geology, McGraw Hill., New York(2005 | | |
| **References Books**  **(Latest editions, and the style as given below must be strictly adhered to)** | | | |
| 1. | Introduction to Mineralogy – William D. Nesse (2000), Oxford University press, New York. USA. | | |
| 2. | Textbook of Mineralogy – E.S. Dana, (2000), 3rd edition, CBS Publishers & Distributers, New Delhi. | | |
| 3. | Crystals and Crystal Structures – Richard J. D. Tilley(2006), John Wiley & Sons, England. | | |
| 4. | Introduction to Mineralogy, Crystallography & Petrology – Carl W. Correns (1967), 2nd edition, Springer | | |
| 5. | Radhakrishnan, V, General Geology, V.V.P. Publishers, Tuticorin (1996) | | |

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| --- | --- |
| **Web Resources** | |
| 1. | "Age of the Earth". U.S. Geological Survey. 1997. Archived from the original on 23 December 2005*.* Retrieved 2006-01-10. |
| 2. | Dalrymple, G. Brent (2001). "The age of the Earth in the twentieth century: a problem (mostly) solved". Special Publications, Geological Society of London. |
| 3. | Geo.libretexts.org |
| 4. | www.nationalgeographic.org |
| 5. | Solarsysytem.nasa.gov |

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

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

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

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
| **CO 1** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO 2** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| **CO 5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |

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